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TAYLOR (J. S.). **Notes on *Phiala patagiata* Aur., the Karoo Tent Caterpillar.**—*Ent. Mem. Dep. Agric. S. Afr.* **2** pt. 8 pp. 219–229, 2 figs., 1 ref. Pretoria, 1950.

Phiala patagiata Auriv., of which the immature stages are described and the original description of the adult is quoted, is widely distributed in the Karroo districts of South Africa. It sometimes causes serious damage to the important fodder plant, *Pentzia incana,* in the eastern Cape Province, where this is its main food-plant, and it also occurs in the north-eastern Cape Province and the eastern Orange Free State, where, however, it chiefly attacks *Walafrida saxatilis* and only occasionally injures *P. incana.* Its occurrence on *P. incana* is governed largely by climatic conditions, since adequate autumn and winter rains that ensure a plentiful supply of succulent food are necessary for it to become numerous, and it is reduced and its development retarded by drought.

An account of the bionomics of this Eupterotid is given, based on observations over a period of four years. It has one generation a year. The eggs are deposited in clusters of 250 or more on the shoots and branches of the food-plant, and there is usually only one cluster per plant. The egg and larval stages last about one and 4–6 months, respectively. Newly hatched larvae have been observed from mid-April and full-fed larvae from mid-July, but when food supplies are scarce, larval development may not be completed until October or November. The larvae feed gregariously on the leaves within a silken web that eventually almost envelops the food-plant and usually reaches 8–10 ins. in diameter. When the leaves have been eaten, they leave the plant during the day and attack others up to at least 6 ft. away, returning to the web at night. Under drought conditions, the larvae migrate to plants in damp situations, but do not apparently make new webs. Pupation takes place in the soil. There is considerable variation in the rate of development of the larvae, even those from a single egg batch, and of 40 that hatched on 11th May 1948 and were kept out of doors on growing *Pentzia* plants, the first entered the soil on 17th September and the last on 10th November. In outdoor cages, adults emerged between 8th February and 4th April, most doing so in March. Males and females survived for averages of 4·6 and 3·5 days, respectively. Fertilised females oviposited on the second or third night after emergence, and totals of 225–276 eggs were found in females that failed to oviposit. Unfertilised females deposited eggs singly or in small clusters over several nights.

In September 1946, at least 90 per cent. of the larvae at a place in the Cape Midlands were parasitised by *Sturmia* (*Zygobothria*) *inconspicua* (Mg.) and up to four of this Tachinid completed their development in one host. The high percentage of parasitism may have been due to the fact that the host larvae were concentrated in a relatively small area ; there was no reduction in infestation there in the following year. An Ichneumonid was also found parasitising *Phiala patagiata* in small numbers at another place, and the larval webs were often broken open, probably by insectivorous birds. No satisfactory control measures against this pest are known.

LAPORTE (M. L.). **Les parasites de *Chrysomphalus ficus* Ashm. (Hom. Coccoidea) en Algérie.**—*Rev. Path. vég.* **28** fasc. 3 pp. 150–158, 1 fig., 23 refs. Paris, 1949.

In Algeria, *Chrysomphalus ficus* Ashm. is a serious pest of *Citrus* and many ornamental shrubs but occurs only along a coastal zone some 12½ miles long near Algiers, where it reproduces intensively and passes through four generations a year [*cf.* *R.A.E.*, A **16** 670]. Some 20 years ago, the control afforded by natural enemies of this Coccid was slight, but it has since increased and investigations in 1947–48 and 1948–49 showed it to be considerable. The

predators comprised not only *Chilocorus bipustulatus* (L.) [*cf. loc. cit.*], but also *Lindorus* (*Rhizobius*) *lophanthae* (Blaisd.) [*cf.* **26** 410], which was much the more important. Of the parasites previously recorded [**16** 670; **18** 85], only *Aphytis chrysomphali* (Merc.) was found, two examples being reared from males on orange and one from a female. Other parasites reared from the females in both periods comprised *Habrolepis pascuorum* Merc. and *Chiloneurinus microphagus* (Mayr), which were by far the commonest, and *Comperiella bifasciata* How. and *Aspidiotiphagus citrinus* (Craw), which were rare; single individuals of two unidentified species were also obtained in the first period.

Notes are given on the seasonal occurrence of the parasites and on records of them from other hosts and countries. *H. pascuorum*, of which both sexes were present in almost equal numbers though the males are unknown in Spain and Sicily, was very active during the whole of the hot season, while the mean temperature was above 15°C. [59°F.], but decreased from about the last week in November, until February. *Chiloneurinus microphagus*, however, was active only in December–January, when it attacked the fourth generation of the scale. The other parasites were also recovered late in the season, between September and the middle of January. Total parasitism of females of *Chrysomphalus ficus* was in general high. It reached 85 per cent. in November 1947, and hardly any unparasitised examples were present on *Citrus* later in that month, but was less intense during the second period of observation.

HOFFMANN (A.). **La flore spontanée et la pullulation des insectes nuisibles aux cultures.**—*Rev. Path. vég.* **28** fasc. 3 pp. 159–162, 9 refs. Paris, 1949.

The author gives four examples from his own experience in north-western France of the spread of insects that breed on weeds to cultivated plants botanically related to the latter and growing in their proximity. In addition to one already noticed [*R.A.E.*, A **17** 410], the species concerned were *Ceuthorrhynchus apicalis* (Gylh.), larvae of which were found mining in the upper part of the root-collars and at the base of the petioles of celeriac in 1939, the probable source of the infestation being *Heracleum sphondylium*, which had for many years been growing at the edge of the field and was similarly attacked; *C. terminatus* (Hbst.), larvae of which injured the root-collars of parsley in 1948, the source of the infestation being *Chaerophyllum tenulus*, which was abundant on the paths leading to the parsley plots; and *Lixus junci* Boh., larvae of which caused severe injury to beet grown for seed in 1946 by mining in the stems of the inflorescences and in the upper parts of the roots, *Chenopodium album* being the source.

D'AGUILAR (J.). **Remarques sur l'action de l'H.C.H. sur diverses variétés de pommes de terre et de pois.**—*Rev. Path. vég.* **28** fasc. 3 pp. 163–169, 2 figs., 9 refs. Paris, 1949.

BHC (benzene hexachloride) is being widely used as a soil insecticide for the control of wireworms and Melolonthid larvae, and since it has been found to have various effects on plants growing in soil treated with it [*cf. R.A.E.*, A **39** 283], a study was made of its effects on potatoes and peas in north-western France in 1947–48. Two tests were carried out with potatoes. In the first, tubers of eight varieties were planted in April 1947 and BHC was applied to the soil in the rows at the rate of 18 lb. per acre on the same day. Plant growth was measured at the end of the season (in July) and tuber yields were weighed. The results showed that, except for one variety in which plant growth was increased and another in which yield was greater, all the plants in the treated soil were reduced in growth and yield, as compared with the

controls. In the second test, BHC was broadcast at 27 lb. per acre in September 1947, tubers of the same eight varieties and one other were planted in April 1948, and the same measurements were later made. In this case, five varieties showed taller growth and four of them increased yields, as compared with the controls, one showed similar growth but a greatly increased yield, and the rest were reduced in both growth and yield. In the first test there was some tainting and delay in maturation of the tubers, while in the second, tainting was much less and maturation unaffected.

In the single test on peas, BHC was broadcast in April 1947 at 18 lb. per acre and seed sown on the same day. Plant growth and yield were both greater for the plants in the treated soil than for the controls, and the peas were not tainted.

RUNGS (C.). **Observations préliminaires sur deux Hyménoptères Tenthredinidae nuisibles aux cultures florales au Maroc.**—*Rev. Path. vég.* **28** fasc. 3 pp. 170–174, 1 fig., 1 ref. Paris, 1949.

In April 1938, larvae of *Athalia cordata* Lep. were abundant on cultivated snapdragon (*Antirrhinum majus*) at Rabat, Morocco, and completely defoliated many of the plants. In the adjoining fields, they occurred on the wild *A. orontium*, which seems to be the normal foodplant of this Tenthredinid. Studies on its annual cycle were carried out from April 1938 to November 1940 in cages placed in the open, and details of the results are given. They showed that its development was well adapted to that of *A. orontium*, proceeding from the beginning of the autumn rains in October or November until that of the dry summer heat in June. Three generations and sometimes a partial fourth are produced in this time, depending on the earliness of the autumn rains, and the summer is passed by the larvae in diapause. The eggs are laid in slits in the lower surface of the leaves, and pupation occurred in the soil.

Cultivated violets [*Viola*] in the district of Rabat are defoliated each year and the flowers destroyed by the larvae of a Tenthredinid identified as an undescribed variety of *Protemphytus pallipes* (Spin.), which are described. Observations on its bionomics showed that the eggs are laid singly in slits in the upper surface of the leaves and that pupation occurs in the soil or in vegetable débris close to the beds. There were three generations a year, and adults of the third emerged from mid-June to mid-July, but as the violet plants had dried up by that time, preventing oviposition, and it seemed unlikely that these adults could survive through the summer until autumn, it is probable that some of the third generation aestivate in an earlier stage. There was some evidence that the larvae were parasitised by a species of *Medetera*.

BERAN (F.). **Die Frostspritzung, eine Möglichkeit zur Erhöhung der Wirksamkeit ölhältiger Winterspritzmittel.** [Spraying during Frost, a Possibility of increasing the Effectiveness of Winter Sprays containing Oil.]—*Pflanzenschutzberichte* **2** pt. 11–12 pp. 161–175, 5 refs. Vienna, 1948. (With a Summary in English.)

It is commonly held that dormant sprays of tar-distillate preparations (fruit-tree carbolineums) or mineral oil for use on fruit trees should not be applied in frosty weather, but since a search of the literature revealed no good reason for this prohibition, its validity was tested by the author in Austria. In a preliminary experiment in the winter of 1946–47, young apple trees infested by *Quadraspidiotus* (*Aspidiotus*) *perniciosus* (Comst.) were sprayed at −5°C. [23°F.] with 8 per cent. of a heavy-oil carbolineum (7 per cent. actual oil). This resulted in complete mortality of the scales, normal development of the trees in the spring, and protection from reinfestation during the whole of

the vegetation period, though trees in the surrounding area were heavily infested. A conspicuous oil deposit persisted on the trunks throughout the season.

Further tests were carried out in 1947–48. In the first of these, in which the trees were sprayed at −4·5°C. [23·9°F.] or at temperatures above freezing point with 4 per cent. of the carbolineum and the oil deposits extracted from samples of the bark, the deposits averaged 0·79 and 0·35 mg. per sq. cm., respectively. The increase in the deposit at the low temperature was evidently due to the reduced run-off, the liquid on the trunks becoming congealed as soon as it was applied and the whole of the oil being retained. A subsidiary test in which a stock emulsion of tar distillate (emulsified with sulphite lye) and the carbolineum were applied with and without a wetter at an equal oil concentration confirmed that the oil deposit varies with the surface tension of the spray, and it is concluded that this should not be less than 34 or more than 40 dynes per cm.

To determine whether treatment in frosty weather would allow of a reduction in the concentration of oil sprays and whether there was any similar effect with lime-sulphur, four year-old apple trees of several varieties showing medium infestation by *Q. perniciosus* were sprayed in December 1947 and January–February 1948 at temperatures varying from −1 to −10°C. [30·2–14°F.] with 4–8 per cent. of the heavy-oil carbolineum, 2 or 3 per cent. mineral-oil emulsion or 10 per cent. lime-sulphur (33°Bé.). For comparison, other trees were taken indoors, sprayed at temperatures of 1–14°C. [33·8–57·2°F.] and replanted in the open. The results were estimated between 23rd March and 20th April 1948 by counts of living and dead scales on the bark and percentages of control were calculated from comparison with the mortality figures for no treatment. For the carbolineum, these percentages were usually 100 for sprays applied at temperatures below freezing point and varied irregularly from 39·9 to 100 (reached in only one instance) for those applied above it. For the mineral oil, they were 100 for all sprays applied at −10°C. and 23·2–49·7 for those applied at 14°C., and for lime-sulphur they were 98·3–100 at −5°C. and 87·7–98·3 at 10°C. [50°F.]. Spraying with water alone showed that the formation of ice does not in itself affect the scales.

Apple, pear, plum and cherry trees 4–5 years old sprayed with carbolineum or mineral oil at −10 or −6°C. [21·2°F.] showed no spray injury, and though peach trees were injured, the damage was no greater than occurred at 12°C. Tests with apricot were inconclusive, as the trees were injured by frost, but they all developed normal foliage in summer.

It is concluded that spraying at temperatures below freezing point allows the concentration of mineral-oil or tar-distillate sprays to be halved, without loss of effectiveness, and it is recommended at least for experimental spraying against *Q. perniciosus* in severely infested orchards. Some trouble was experienced owing to the formation of ice on nozzles of low-pressure apparatus, so that they had to be changed from time to time, but high-pressure apparatus was not affected.

JAHN (E.). **Beobachtungen über Parasitenauftreten im Zusammenhang mit dem Massenauftreten des grauen Lärchenwicklers,** *Grapholitha* (*Semasia*) *diniana*, **in Tirol im Jahre 1947.** [Observations on the Occurrence of Parasites in Connection with the Outbreak of the Grey Larch Tortricid, *Enarmonia diniana*, in Tyrol in the Year 1947.]—*Pflanzenschutzberichte* **2** pt. 11–12 pp. 176–182, 2 refs. Vienna, 1948. (With a Summary in English.)

The outbreak of *Enarmonia* (*Grapholitha*) *diniana* (Gn.) on larch in Tyrol that began in 1946 [*cf.* *R.A.E.*, A **39** 75] collapsed early in 1948, when few

larvae were observed on the trees and most of these died in the first instar. This was the result mainly of high larval mortality due to parasitism in 1947 [*cf. loc. cit.*] and polyhedral disease, which broke out among the larvae in 1948. Lists are given of the parasites reared from the larvae of *E. diniana* in 1947, and those obtained from *Coleophora laricella* (Hb.) and *Zygaena filipendulae* (L.), both of which occurred on the trees infested by *E. diniana*, though the Zygaenid does not feed on larch. Notes on the alternative hosts of most of the parasites and the habits and seasonal occurrence of some are included. Those reared from larvae of *E. diniana* comprised the Braconids, *Bracon* (*Habrobracon*) *stabilis* Wesm. (which was the commonest of all the parasites) and *Apanteles impurus* Nees, the Cleonymid, *Cheiropachys colon* (L.), the Pteromalid, *Amblymerus punctiger* (Thoms.), the Eulophids, *Chrysocharis aeneiscapus* (Thoms.) and *Elachertus petiolatus* (Spin.), and the Ichneumonids, *Pimpla turionella* (L.) (*examinator* (F.)), *Agrypon flaveolatum* (Grav.), *Phaeogenes modestus* Wesm. and *P. scutellaris* Wesm. var. *dinianae*, n. Characters of the adult distinguishing var. *dinianae* from the typical form of *P. scutellaris* are given by Fahringer. *P. osculator* (Thnb.) (*nanus* Wesm.) was reared from larvae of *Enarmonia diniana* in Carinthia. The parasites recorded from *Coleophora laricella* were the Ichneumonid, *Angitia armillata* (Grav.), the Braconid, *B.* (*H.*) *concolor* Thoms., and the Eulophid, *Cirrospilus pictus* (Nees), all of which parasitise the pupae, and those from *Z. filipendulae* were the Braconid, *Apanteles zygaenarum* Marsh., and the Ichneumonid, *Agrothereutes* (*Spilocryptus*) *solitarius* (Tschek.), which parasitise the larvae and pupae, respectively.

GOURLAY (E. S.). **Notes on Insects associated with *Pinus radiata* in New Zealand.**—*Bull. ent. Res.* **42** pt. 1 pp. 21–22, 2 refs. London, 1951.

One of the indigenous insects here recorded for the first time in association with *Pinus radiata* in New Zealand is the Oryssid, *Guiglia schauinslandi* (Ashm.), which was observed on two occasions parasitising larvae of *Sirex noctilio* F. in dead logs of *P. radiata* examined in connection with the collection, rearing and distribution of *Rhyssa persuasoria* (L.) for the control of *Sirex* [*cf. R.A.E.*, A **36** 244]. The probable native hosts of the Oryssid are the weevils, *Psepholax sulcatus* White, *P. barbifrons* White and *P. coronatus* White, the last of which is known to attack *Pinus radiata* [**20** 378]. The adult parasites emerge in October–December, but adults of *S. noctilio* emerge between mid-January and April. The host larvae are not therefore attacked until they are nearly mature, when they move to pupation sites near the surface of the trunk and come within reach of the ovipositor of the parasite. *G. schauinslandi* may sometimes parasitise *R. persuasoria*, which also attacks the older larvae of *S. noctilio* but does not kill them till they are near the bark. The percentage parasitism due to *G. schauinslandi* must be low, since only a few dozen emerge each year in the insectary, compared with thousands of *S. noctilio* and *R. persuasoria*. The other insects recorded are the Cerambycid, *Stenopotes pallidus* Pasc., and the Anthribid, *Brachytarsus* (*Anthribus*) *sharpi* (Broun), the larvae of both of which develop beneath the bark of dead *P. radiata*.

WILLIAMS (J. R.), MOUTIA (L. A.) & HERMELIN (P. R.). **The Biological Control of *Gonipterus scutellatus* Gyll. (Col. Curculionidae) in Mauritius.**—*Bull. ent. Res.* **42** pt. 1 pp. 23–28, 10 refs. London, 1951.

An account is given of the discovery of *Gonipterus scutellatus* Gylh. on *Eucalyptus* in Mauritius [*R.A.E.*, A **34** 101], the introduction of the Mymarid parasite *Anaphoidea nitens* Gir., against it [**36** 125] and the early results of liberations [**36** 125 ; **38** 190]. In two surveys carried out in July–August and November–December 1948, in each of which egg capsules of *Gonipterus* were

collected from 21 localities, parasitism of the eggs by *A. nitens* averaged 29·3 and 39·5 per cent., respectively, and varied from 1·1 to 99·4 and from 7·6 to 86·6 per cent. Notes on the bionomics of both insects in Mauritius are also given. In the laboratory, adult parasites paired soon after emergence, and in the presence of abundant host eggs, the females laid an average of 27 eggs each, about half of which were deposited within 24 hours of mating. Fewer eggs were laid in egg capsules four days old than in younger ones, very few in capsules five days old and none in older ones. The ratio of males to females in the field was 2 : 3. In a laboratory experiment, only one of 20 unfertilised females produced progeny, and all were male. Adults of *G. scutellatus* paired 4–9 days after emergence, and the females oviposited after a further 13–21 days. They laid 21–33 egg capsules, each containing an average of ten eggs. Oviposition continued throughout the adult life of the females, which averaged 91 days.

As a result of the spread and activity of the parasite, outbreaks of *Gonipterus* in Mauritius have become sporadic and localised, and observations in 1948 and 1949 indicated that they are checked before they cause extensive damage. The degree of parasitism varies considerably from place to place at the same season and in the same place at different seasons. This is attributed to the wide disparity between the reproductive rates of the host and parasites. The frequent high winds appear to have no detrimental effects on the parasite.

RAWLE (S. G.). **The Effects of high Temperature on the Common Clothes Moth, *Tineola bisselliella* (Humm.).**—*Bull. ent. Res.* **42** pt. 1 pp. 29–40, 2 pls., 4 graphs, 8 refs. London, 1951.

Recommendations for the control of *Tineola bisselliella* (Humm.) by heat treatment have mostly been based on exposure to temperatures above 43°C. [109·4°F.] [*cf. R.A.E.*, A **15** 187], but as such high temperatures are not readily obtainable in private houses, experiments were carried out to ascertain exposures that would give complete mortality at 30–41°F. [86–105·8°F.]. Eggs, larvae, pupae and adults from a laboratory culture were exposed separately, and the results are shown in tables. Relative humidity was not an important factor, but was usually maintained at 70 per cent., though constant humidities of 30, 50 and 90 per cent. were used at some of the lower temperatures. All the pupae and adults were killed by exposure for one day to 38°C. [100·4°F.] and all the larvae by exposure for 18 hours ; for complete mortality of the eggs, however, exposure to 37°C. [98·6°F.] for two days or 39°C. [102·2°F.] for one was required. Exposure for four hours to 41°C. gave complete mortality of all stages, but some eggs survived exposure for four hours to 40°C. [104°F.]. Development and reproduction occur at 33°C. [91·4°F.]. Eggs hatched at 35°C. [95°F.], but the larvae did not pupate, and though some fully grown larvae exposed to that temperature pupated, they did not give rise to adults. The males are rendered sterile in two days or less by exposure to 35°C., so that although eggs are laid at that temperature, very few are likely to be viable.

DIRSH (V. M.). **A new Grasshopper (Orth. Acrididae) damaging Groundnuts.**—*Bull. ent. Res.* **42** pt. 1 pp. 41–43, 9 figs. London, 1951.

Pyrgomorphella arachidis, sp. n., is described from adults of both sexes taken in Tanganyika Territory in 1946 and 1947. It is stated by E. Burtt to occur over wide areas of the Lake Province, as well as further west, and to damage young groundnuts in December, when the plants are about two weeks old. It causes serious injury in seasons of heavy rainfall, but is rarely numerous when rainfall is low. It feeds on wild plants until groundnut is available and has been recognised as a pest in one district for over 30 years. Although there is reported to be only one generation a year, with adults present in April and May, there are probably at least two in favourable seasons.

HOWE (R. W.). **The Movement of Grain Weevils through Grain.**—*Bull. ent. Res.* **42** pt. 1 pp. 125–134, 1 pl., 4 graphs, 3 refs. London, 1951.

Under commercial conditions, heating in grain stored in bulk due to infestation by *Calandra* is most likely to be caused by populations at the centre of the mass. D. P. Pielou found that weevils moved up vertical glass tubes, 4 ft. long and 1 in. in diameter, when placed at the bottom but did not move down from the top, but earlier experiments by the author demonstrated an upward movement in a heating bin of wheat [*R.A.E.*, A **31** 417–418]. In order to discover whether and under what conditions weevils will penetrate to the centre of a bulk of grain and whether they will remain in the centre if originally placed there, observations were made in the laboratory in which adults of *Calandra granaria* (L.) and the large and small strains of *C. oryzae* (L.) were placed separately or together at various depths in wheat in iron towers 26 or 52 ins. high and 4 ins. in diameter or in a wooden box filled with grain ; with either apparatus, the grain masses could be readily broken down into samples. The following is taken from the author's summary of the results. It was found that the predominant movement of weevils was towards the bottom. The major factor affecting movement was tightness of packing, but although tight packing restricted movement, it did not prevent oviposition. Small insects moved more easily through the grain than bigger ones and also showed a greater tendency to move downwards. Increase of moisture content, which increases the amount of airspace, also increased the ease of insect movement. The results of experiments giving the weevils a choice of moisture content were somewhat contradictory. This was due partly to the effect on the choice of the weevil of the humidity experienced prior to the test and partly to the subordination of moisture choice to the greater attraction of the end of the grain column. On the whole, however, damper grain appeared to be preferred to dry grain.

In the field, owing to the tighter packing, movement is likely to be more restricted than in these experiments. The tight packing will prevent much of the downward penetration of weevils observed in these experiments but some such movement may occur on the walls and posts. Where insects are originally placed in the centre of a bulk of grain they will often be immobile but will lay eggs and be liable to cause heating. It is clear that the insects will tend to move towards the edges of the bulk and remain there.

KRIJGSMAN (B. J.) & LINGBEEK (T.). **Contact Activity and real Toxicity of some Iodo-nitrobenzene Compounds.**—*Bull. ent. Res.* **42** pt. 1 pp. 135–141, 16 refs. London, 1951.

An account is given of laboratory experiments on the contact effect of the p-, m- and o-iodo-nitrobenzenes and their dichlorides. Contact effect under field conditions results from a combination of real toxicity (toxicity at the site of action in the tissues) and permeation velocity. For the compounds under test, real toxicity was estimated by injecting known volumes of acetone solutions emulsified in physiological salt solution into the abdomen of weighed cockroaches (*Periplaneta americana* (L.)), and values for permeation velocity were calculated from these results and those obtained in tests of total contact action against *Calandra granaria* (L.) carried out by a technique already noticed [*R.A.E.*, A **38** 47]. The standard of comparison for permeation velocity was γ BHC (benzene hexachloride), which was assigned an arbitrary value of 1,000 units. On the basis of this figure, the corresponding value for any other compound is 1,000 ab/xy, where a and x are the median lethal doses by injection of the test compound and γ BHC, and y and b their median lethal doses by contact, respectively. The results of the individual experiments are

given, and a table is included in which the median lethal doses and the permeation velocities of the six compounds and also those of some other compounds based on earlier experiments are compared with those of γ BHC. The median lethal doses by injection in mg. per kg. and (in brackets) the permeation velocities are 17 (1,000) for γ BHC, 1 (590) for pure parathion, 1·5 (35) for tetraethyl pyrophosphate (95 per cent. pure), 9 (32) for technical chlordan (Velsicol 1068), 20 (24) for p,p′ DDT, 85 (40) for pure dinitro-o-cresol, 10 (less than 0·08) for pure crystalline rotenone, and 270 (58), 410 (less than 3) and 355 (9) for p-, m- and o-iodo-nitrobenzene and 155 (75), 310 (less than 2) and 205 (3) for the corresponding dichlorides, respectively. The real toxicity of the para isomers of the test compounds was thus little higher than that of the other isomers, though their contact action was much higher owing to differences in permeation velocity. It is suggested that the enhanced effect of the para position on permeation velocity is a general rule.

The permeation velocity of p-iodo-nitrobenzene was so high that this compound must be considered a promising contact insecticide, although its real toxicity is less than that of several other modern insecticides.

Krijgsman (B. J.) & Krijgsman-Berger (N. E.). **Physiological Investigations into the Heart Function of Arthropods. The Heart of** ***Periplaneta americana.***—*Bull. ent. Res.* **42** pt. 1 pp. 143–155, 39 refs. London, 1951.

The following is virtually the authors' summary of this account of experiments on the effect of various drugs on the isolated heart of *Periplaneta americana*, prepared and mounted as described in an earlier paper [*R.A.E.*, A **38** 312]. Perfusion of the isolated heart of *P. americana* with caffeine, digitalin, acetylcholine, nicotine and lobeline shows that the pacemaker of this heart is different from the " myogenic centre " of the vertebrate heart. The action of strychnine, morphine and apomorphine on this heart preparation affords evidence of the existence of a neurogenic pacemaker. This pacemaker is stimulated by suitable concentrations of acetylcholine, nicotine, lobeline and pilocarpine, while it is inhibited by atropine. Acetylcholine and TEPP (tetraethyl pyrophosphate) show a synergistic action. Atropine and TEPP, like acetylcholine and curare, show an antagonistic action. These results prove that the neurogenic pacemaker possesses cholinergic properties. Adrenalin stimulates the insect heart and ergotamine inhibits it, thus suggesting that the insect heart probably also has adrenergic properties. On the basis of the present work and the results obtained by other investigators, a theory is put forward that the heart mechanism of most arthropods consists of a neurogenic pacemaker with adrenergic properties, controlled by a cholinergic accelerating nerve. This mechanism bears some resemblance to the sympathetic nerve system of vertebrates. Rotenone strongly counteracts the action of acetylcholine, TEPP, nicotine, lobeline, pilocarpine and digitalin on the insect heart. Its point of action, however, remains obscure. The opposing action of rotenone and TEPP is an indication that a combination of these insecticides for pest control is not to be recommended.

Darling (H. S.). **Pink Bollworm,** *Platyedra gossypiella* **(Saund.), as a Pest of Cotton at Zeidab, northern Sudan.**—*Bull. ent. Res.* **42** pt. 1 pp. 157–167, 1 graph, 9 refs. London, 1951.

The following is largely the author's summary. Losses from *Platyedra gossypiella* (Saund.) and *Earias insulana* (Boisd.) were studied in the American Upland cotton crop grown on pump-irrigated land at Zeidab, in the Northern Province of the Anglo-Egyptian Sudan. In 1948, a year of normal attack, 10·7 per cent. of the estimated potential yield was destroyed by *P. gossypiella* and 2·2 per cent. by *E. insulana*. Of the total yield, four-fifths is derived

from the bottom crop, which is harvested before the end of September and consists of high-grade seed cotton. The other fifth is produced as a top crop and consists of low-grade seed cotton ripening in October and November. Only 3·5 per cent. of the bottom crop was lost on account of *P. gossypiella*, as compared with 33·3 per cent. of the top crop. The corresponding percentages for *E. insulana* were 1·6 and 4·1.

Some factors influencing the extent of attack by *P. gossypiella* are outlined. The Zeidab crop escapes serious damage through rapid maturity and even growth. Correct agricultural management is of great importance. Attack by *Laphygma exigua* (Hb.) in the seedling stage probably results in increased damage by *P. gossypiella* in the ripening crop. The origin of the initial infestation by *P. gossypiella* is discussed. Owing to the dead season, no crops are available for a period of several months, and the adults are not known to survive for longer than one. Alternative food-plants are not attacked to any extent in the area, and although some seed cotton is almost certainly stored illicitly, the quantities involved are probably not adequate to account for the observed intensity of initial infestation. Larger stocks of seed cotton are probably stored to the north and south of the area, and there may be some immigration from these districts or even from farther afield.

Atmospheric humidity appears to influence the duration of larval diapause in *P. gossypiella* in the northern Sudan. Maximum emergence of moths derived from resting larvae in three areas occurs at or near the lowest saturation deficit of the year. The possibility is discussed that the degree of fixity of the diapause may be related to the gradient of the saturation-deficit curve during the development of the resting larvae in the crop, a rising curve being associated with a well fixed diapause that lasts until the saturation deficit falls, and a falling curve being associated with a poorly fixed diapause that does not last but begins to break at once.

STRICKLAND (A. H.). **The Entomology of Swollen Shoot of Cacao. II. The Bionomics and Ecology of the Species involved.**—*Bull. ent. Res.* **42** pt. 1 pp. 65–103, 3 figs., 20 refs. London, 1951.

The following is based on the author's summary of this second paper of a series [*R.A.E.*, A **39** 303]. Routine quantitative estimations of mealybug populations on cacao trees at Tafo, in the Eastern Province of the Gold Coast, were made each month over a period of two years from samples comprising twelve felled trees taken from each of ten one-acre plots ; the results, which are given in tables, were so variable that only gross differences in population densities were shown to be statistically significant. From analyses based on the survey data, it is concluded that *Pseudococcus njalensis* Laing, the most numerous of the mealybug vectors of the virus that causes swollen-shoot, is almost invariably attended in the field by ants of the genus *Crematogaster*, which build protective carton tents over the mealybugs [*cf.* **36** 110]. The density of these ants and the numbers and size of the carton tents are correlated with the numbers of mealybugs to be protected. Investigations on arboreal ants of the groups of the subgenera *Crematogaster*, *Atopogyne* and *Sphaerocrema* showed that the *Crematogaster* group constructed a larger mean number of carton tents per tree and was associated with consistently higher mealybug populations than the *Atopogyne* group, and was itself inferior in both respects to the *Sphaerocrema* group. Variation from tree to tree in mealybug density was found to be largely dependent on the identity of the dominant ant group. No direct correlation was apparent between mealybug density and incidence of swollen-shoot, though populations in areas devastated by the virus are usually smaller than in those in which the virus is actively spreading.

The factors of importance in the natural control of *P. njalensis* are discussed in some detail. It is clear that the species is maintained by ant protection at a density level considerably above that prevailing among closely related mealybugs that are not attended by ants to the same extent. At this level of " protected steady density ", balance is maintained partly by losses during crop harvesting and partly by the occurrence of swollen-shoot disease, which renders the trees unsuitable for feeding. It is concluded, however, that natural enemies [*cf.* **39** 304] must be ultimately responsible for maintaining balance. Since the protected density of *P. njalensis* is a direct result of ant association, it follows that factors tending to control the attendant ant species will have a delayed effect on mealybug density. In this respect, it is believed that *Oecophylla* [*longinoda* (Latr.)], which shows a strong negative correlation with *Crematogaster* spp., is of importance [*cf.* **39** 304]. Any attempts to control the mealybugs by killing the ants will have to be designed as specific against the genus *Crematogaster* and non-lethal to *Oecophylla* and the other large predacious ants common on cacao.

VOELCKER (O. J.). **Annual Report of the West African Cacao Research Institute, April, 1947 to March, 1948.**—85 pp. Tafo, 1949. **April, 1948 to March, 1949.**—64 pp. 1950.

These two further reports of investigations on cacao carried out mainly at Tafo in the Gold Coast and Owena in Nigeria [*cf. R.A.E.*, A **37** 85] each contain sections dealing with work on viruses and on Mirids (Capsids). During research on Nigerian viruses that cause swollen shoot of cacao described in the first report, dying cacao that showed distinctive symptoms but no swellings was found at Asalu (Nigeria) and similar symptoms were later observed on cacao at a place in Ashanti (Gold Coast). The virus from Asalu, which is referred to in the second report as strain S, was transmitted by grafting, but not by the insect vectors of swollen shoot [*cf.* **39** 47]. It did not confer immunity against strain C, which also fails to cause the development of swellings. Budwood collected in June 1948 from infected trees at Alaparun (Nigeria) transmitted a new cacao virus (strain R) to test plants at Tafo. It was transmitted by *Pseudococcus njalensis* Laing, but not by *Ferrisia virgata* (Ckll.). During work on the strain F virus complex in the Western Province of the Gold Coast, in which budwood was collected in November 1946 from outbreak centres near Wiawso and grafted on seedling cacao, at least eight viruses were found to be present in the area ; these are classified in four major groups, referred to as the mosaic, yellow mosaic, yellows and clearings classes, and the characteristic leaf symptoms of each are shown in a table. Some of these viruses were almost as virulent as strain A, but viruses from the Western Province are in general mild [**37** 85]. None inhibited infection with strain A. Viruses very similar to and in some cases probably identical with recognised ones in the mosaic and yellow mosaic classes were obtained from *Cola chlamydantha*. Additional virus strains that do not confer immunity against strain A [*cf.* **37** 86] recorded in the first report are D, E, G, N (Akanran), O_1 (Alanla), O_2 (Alanla) and O_3 ; in the second report, it is stated that strains C and M appear to be unrelated to any other cacao viruses and that strain X (Kongodia) from the Ivory Coast is probably related to strain A [*cf.* **39** 288]. Cacao viruses with leaf symptoms differing conspicuously from those of strain A are unlikely to confer immunity against it, though the converse is not true. Of the Nigerian viruses, O_1 and O_2 are mutually protective, O_3 confers immunity against both, and strain N against neither.

In the first report, it is stated that the symptoms on leaves of the first flush produced after virus infection are usually severe (acute phase), whereas those in leaves produced later are milder and often dissimilar and in the case of mild

viruses may be absent (chronic phase). This succession of phases is not brought about by a qualitative change in the virus. It is inferred from experiments that acute symptoms develop only in shoots from dormant buds produced prior to infection, whereas those from buds formed during the chronic phase and presumably infected while in the embryonic stage show chronic symptoms or none. Furthermore, there is a marked tendency for the strongest symptoms of a flush to develop on the lower, first-formed leaves.

It has been assumed that viruses are unable to build up in seeds developing on diseased trees, but in experiments described in the second report, adults and crawlers of *P. njalensis* transmitted strain A to cacao beans after feeding on the testae of seeds from immature pods showing symptoms of infection. There was no increase in transmission when germinating beans were used as the source of infection.

It is concluded from experiments recorded in the first report that strain A exists as a complex of strains differing in virulence ; that in outbreaks involving 50 or more trees extensive variability is the rule, though a tree seldom becomes infected either completely or dominantly with attenuated strain A ; and that in most trees, one strain appears to be either the sole or the dominant virus, though a slightly milder strain may occur in the roots. Tests in 1947–48, in which adults of *F. virgata* and *P. njalensis* were allowed to feed on infected seedlings and the nymphs produced on them subsequently transferred to test beans, indicated that attenuated strain A is transmitted as readily as the virulent strain during the acute phase or at a recurrence of the symptoms, but becomes less available as the plants enter the chronic phase. These results were confirmed in 1948–49, when there was scarcely any transmission from symptomless infected plants.

It is stated in the first report that no clones of cacao have proved immune to infection. In resistance trials with strain A of which the results are given in the second report, the percentage infection of rooted cuttings of 58 clones of local yield selections of Amelonado and Trinitario types of cacao varied from 10 to 100 and hybrids of two recently introduced Upper Amazon types showed considerable resistance in the cotyledon stage. It is recorded in the first report that the root systems of infected cacao seedlings are reduced, and an experiment showed that the water content and dry weight of the leaves, stems, tap-roots and feeding roots of infected seedlings were less than those of healthy plants.

In connection with work on factors affecting insect transmission described in the first report, some of which has already been noticed [**39** 47], it is stated that a standardised technique has been adopted in which infected seedlings not more than 40 days old are used as source plants and first- and second-instar nymphs of *P. njalensis* as vectors. Experiments showed that the effect of a large number of mealybugs in infecting a plant was no greater than that of the sum of the effects of individuals, so that there is no mass action, and that the probabilities of successful infection by one insect and by 30 are 0·103 and 0·9617, respectively. The infection rate was considerably higher when the seedlings were not more than three weeks old than when they were 4–6 weeks old ; in routine experiments, about 50 per cent. infection was obtained in mature plants and cuttings when 30 nymphs were used per plant. Laboratory experiments indicated that if biological races of *P. njalensis* that do not transmit strain M exist, they are not sufficiently frequent to vitiate the results of transmission experiments. Routine transmissions of strain A do not indicate the existence of biological races of this mealybug differing in ability to transmit. Mealybugs from nine separate collections of *P. citri* (Risso) from Tafo and a pooled collection from Kpeve (Togoland) were tested for their ability to transmit strains A, C and M. All transmitted the three strains, except those from one collection, which failed consistently to transmit C ; the individuals

concerned fall well within the normal range of morphological variation of the species in West Africa. Serial sections of young cacao leaves in which *P. njalensis* was feeding showed that the stylet tracks pass through the cortical cells on a tortuous course and usually end in the xylem or phloem. The rate of penetration was about 0·5 mm. per second for both adults and crawlers on agar, and the stylets reached their greatest depth in up to 30 and about 15 minutes, respectively [*cf.* **39** 47]. In work on alternative host plants of the viruses [**38** 378], it is stated that only viruses of the mosaic and yellow mosaic classes have so far been found in *Cola chlamydantha*, which is confined to the Western Province in the Gold Coast. *C. cordifolia* was infected in the laboratory with strain A by *P. njalensis* and *P. citri*, and with strains C and F by *P. njalensis*; the Offa Igbo strain from Nigeria was also transmitted to and from it. Attempts to infect seedlings of *Triplochiton scleroxylon*, a dominant forest tree, and *Canthium glabriflorum*, a common food-plant of *P. njalensis*, were unsuccessful. *Cola togoensis* in Nigeria was naturally infected with a vein-clearing virus that was transmitted by grafting.

Work on the bionomics of the mealybug vectors, some of which has already been noticed [**39** 303], is described in both reports. It is stated in the first that of 10,475 aggregations of *P. njalensis* found on cacao trees at Tafo, 74·6 per cent. were protected by carton tents made by ants [*cf.* preceding abstract], and in the second, that in these circumstances young shoots are included among the preferred feeding sites, which normally comprise cracks in the bark, the lower sides of pod petioles and old Mirid lesions. *P. citri* and other less selective species prefer pods or young petioles and are not attended by ants to the same extent; 78·3 per cent. of a total of 660 *P. citri* collected on the infested trees in 1947–48 were in the canopy. Mealybug infestation varied from plot to plot, but ant infestation was relatively constant, though the species concerned varied. *P. njalensis* was unattended by ants on only 4 per cent. of 384 trees. Ants of 48 species, predominantly Crematogasterines, were taken on felled infested trees and a further 14 in association with *P. njalensis* and *P. citri* on harvested pods, where Pheidolines predominated. In the second report, it is shown that *P. njalensis* prefers mature cacao to seedlings. *P. njalensis* and *P. citri* both produce 6–8 generations a year in the Gold Coast, and colonies are present throughout the year, but appear to be commoner during the dry season. Parasitism among *P. njalensis* on pods and on felled trees was 1·2 and 3 per cent., respectively, in 1947–48. In the second report, parasitism of adults by internal insect parasites is stated to have varied from 1·6 to 5·4 per cent., depending on the ants present and the mean density of the mealybugs. The percentage mean parasitism among adults of *P. citri*, which is considerably less numerous but less frequently attended by ants, was about 8. When no pods are present on the trees, 84 per cent. of the population of *P. njalensis* is restricted to the canopy. As the pods mature, the percentage infested increases and may be as high as 40 by October, subsequently falling to about 0·5 in February. Many mealybugs are removed on the harvested pods, but numbers on the trees increase again during the dry season (January–March). Highly significant differences were found in virus incidence in areas of high and low vector density, though virus spread and high populations are not invariably associated. A high positive correlation was found between the percentages of infested pods and infested trees, which may enable the present method of determining vector density by felling trees to be discontinued. This is desirable, since injurious infestations are sometimes restricted to small areas. Coccids reported attacking cacao at Tafo for the first time during 1947–48 are *Aspidiotus destructor* Sign., *Aspidiotus* spp. (H 6085 and H 6086), *Aonidiella replicata* (Ldgr.), *Hemiberlesia palmae* (Ckll.), *H. cyanophylli* (Sign.), *Pseudaonidia* sp. (H 6086 (a)), *Selenaspidus* sp. (H 6031), *Lecanium* sp. (H 6038), *Inglisia* sp. (H 6397), *Pseudococcus adonidum* (L.) (*longispinus* (Targ.)) and *Pseudococcus* sp. (H 6306).

It is stated in the second report that there was no significant reduction in mealybug density on seedling cacao that was painted regularly with 2·5 per cent. DDT. Laboratory experiments showed that even when mealybugs are not protected by carton tents, they are difficult to kill with sprays unless they are thoroughly wetted, but dusts gave promising results. When various materials were applied to adults of *P. njalensis* in a dusting tower and the mortality percentages corrected according to Abbott's formula [**13** 331], 0·75 per cent. parathion (E 605) was the most effective and gave 12·5, 95 and 100 per cent. mortality in 24, 72 and 96 hours ; 10 per cent. DDT gave 90 per cent. mortality after 96 hours, and 3 per cent. nicotine and 5 per cent. BHC (benzene hexachloride) only 73 and 26 per cent., respectively, after 120 hours. Nymphs produced during the 24 hours following application were usually dead or died soon afterwards, and little feeding took place. A dust of 0·3 per cent. parathion gave about 90 per cent. mortality of both *P. njalensis* and *F. virgata* in 96 hours, but whereas mortality of *P. njalensis* dusted with 3 per cent. nicotine was 61 per cent. in the same period, that of *F. virgata* reached only 9 per cent. *Anagyrus kivuensis* Comp. was brought to Tafo from East Africa in August 1948 for rearing and liberation against the mealybugs. In laboratory tests, it parasitised *P. njalensis*, *P. citri* and *P. brevipes* (Ckll.).

In connection with the work on Mirids, it is stated that routine collections at Tafo and Owena from the lower part of the trees in 1947–48 continued to show a decline in the numbers of *Sahlbergella singularis* Hagl. and *Distantiella theobroma* (Dist.) [*cf.* **37** 88] and were suspended in the following season. They also showed that *S. singularis*, which was previously thought to prefer mature cacao, occurs in considerable numbers on seedlings and that *D. theobroma*, though showing a significant preference for seedlings, occurs consistently in small numbers on the vegetative parts of mature cacao. Counts of the fresh lesions on samples of twigs from trees felled between September 1947 and February 1948 showed that numbers were significantly lower in October and November, when the Mirids migrate to the pods, and in February, when the population is low. Although extensive feeding takes place in the canopy, it seems to be unimportant as a breeding site. Counts recorded in the second report showed that a smaller proportion of *D. theobroma* than of *S. singularis* occurs on the pods of healthy trees and in pockets of infestation [**37** 88] ; 79 per cent. of *S. singularis* and 90 per cent. of *D. theobroma* were in pockets. Observations summarised in the first report, some of the results of which have already been noticed [**37** 88], indicated that Mirid pockets are permanent foci of infestation, that fluctuations in density within them resemble those outside in showing a well-defined peak at and shortly after the main crop and a less well-defined peak at mid-crop, that Mirids tend to aggregate in pockets, even where surrounding healthy cacao is in full bearing, and that adults developing within pockets move freely in and out of the surrounding cacao. In Mirid pockets in which the affected trees had been coppiced, 85 per cent. of the stumps had produced chupons by 1947–48, and in the following season (2½ years after coppicing), several trees were bearing pods ; Mirid damage was very slight, and all chupons were regularly treated with DDT emulsion [**37** 90]. In other experiments carried out during 1948–49, counts of twigs showing old and recent Mirid damage indicated a definite association of the ants, *Oecophylla longinoda* (Latr.) and (to a rather less degree) *Macromischoides aculeatus* (Mayr), with trees on which the percentage of damaged twigs did not exceed 20, especially where the damage was recent. It is concluded that the observed association of *M. aculeatus* with healthy trees [**37** 89] is due to colonisation of them when Mirid damage has rendered the surrounding trees unsuitable. In December 1947, slight damage by adults of *Helopeltis westwoodii* (White) was observed in small plots of cacao, one on low-lying, poor sand and the other on good soil on higher ground, that were planted

in 1946 in forest reserves on the borders of Ashanti and the Eastern Province of the Gold Coast, as far from established cacao as possible, but there was no evidence of breeding. In 1948, scattered and, in some cases, severe Mirid damage occurred on the higher plot, and a few nymphs of *D. theobroma* were found.

S. singularis was recorded feeding and breeding on fruits of the introduced tree, *Sterculia foetida*, for the first time in 1947–48. Females caged on *Ceiba pentandra, Cola cordifolia, C. nitida, C. togoensis, Cistanthera papaverifera, Triplochiton scleroxylon* and *Bombax* sp. oviposited, but the resulting nymphs completed their development only on the first three. There was better survival in 1948–49 and a table is given showing the duration of the egg and nymphal stages and of total development and the percentage of nymphs that completed their development on two varieties of cacao and all these plants, except *Cola nitida* and *Triplochiton*. Development lasted about 40 days on all except *Bombax* sp. and *C. togoensis*, on which it required 46 and 44·6 days, respectively. A species of *Bryocoropsis* tentatively determined as *B. laticollis* Schum. is frequent on *Uvariodendron* and *Anonidium manii* in Nigeria, but although these trees were frequently in close proximity to cacao, only one record of the Mirid feeding on cacao was obtained [*cf.* **37** 88], when the shoot of a seedling was attacked in 1948–49. It is common on cacao pods in the Gold Coast.

Work on the feeding habits of nymphs of *D. theobroma* described in the second report indicated that the number of feeding lesions made each day and the increase in weight after each moult were not affected by the age of the shoot on which the Mirids fed or by absence of light. The normal number of feeds per instar was about 137 for females and 125 for males, but a few individuals of each sex took considerably more. Females showed a considerably greater increase in weight per feed than males, and Mirids on pods than those on chupons. It is stated in the first report that microscopical examination of stained sections of cacao stems with lesions made by *Sahlbergella singularis* confirmed that the cortical medullary rays and the parenchyma are destroyed by the saliva. Observations on caged individuals feeding on cacao stems showed that fourth-instar nymphs remained at and about one spot for considerable periods, feeding for periods of 20–30 minutes with rests of up to 5 minutes. The feeding periods were prolonged to about 40 minutes at 76–77°F., and shortened to about 5 at 82–83°F., with long resting periods. At 78–80°F., third-instar nymphs fed for 10–15 minutes with very short rests, moving slightly with each feed, so that they caused large contiguous areas of damage. At 84–86°F., the nymphs were very active and sensitive to light and ceased to feed. Feeding was resumed after a long period of starvation, or sooner if the temperature fell. The eggs of *D. theobroma, S. singularis, B. laticollis* and *Helopeltis bergrothi* var. *rubrinervis* Popp. are described and a key to them is given.

Work on the chemical control of the Mirids is described in both reports. In the first, it is stated that the average number of Mirids observed on cacao at Tafo that was painted or swabbed with an emulsified solution of 2·5 per cent. DDT in November 1946 [**37** 90] was reduced to 0·23 per tree in January 1947, when populatious on the controls were at a maximum (1·8 per tree) and injurious. Five months after treatment, numbers on the treated trees exceeded those on the controls, which, unlike the treated trees, were stunted and had few young shoots, but a second application caused an immediate decrease. In another trial on young cacao on an experimental farm, trees painted with the emulsion were protected for seven months, when a second application was made ; the average numbers of Mirids found per quarter-acre plot after the first and second treatment were four and six, respectively, the corresponding figures for the control being 53 and 126. In a large-scale field test, over 20,000 seedlings 18 ins. high were painted with 2·5 per cent. DDT in August 1947, and about the same number left untreated. By February 1948, 0·8 and 17·1

per cent. of the treated and untreated seedlings, respectively, were damaged. The emulsion causes slight browning on young flush tissue, but has little, if any, harmful effect. Growth formed after treatment was not protected, but damage to it was not usually serious. Treatment was repeated during 1948–49; in February 1949, when damage was at its peak, the percentages injured by Mirids on the treated and untreated plants were 0·01 and 26·7, respectively.

In early 1947, unshaded cacao trees at Owena were found to be defoliated and showed numerous dead twigs and branches projecting above the living wood. Mirid lesions were not numerous but *Selenothrips rubrocinctus* (Giard) appeared to be commoner than on neighbouring shaded cacao. Counts were made of nymphs and adults of the thrips on unshaded, moderately shaded and densely shaded cacao twice a month from April onwards. Populations reached a maximum between late December and mid-February, the increase being most rapid on the unshaded and slowest on the densely shaded cacao. Minimum populations were reached on moderately shaded and unshaded cacao at the end of July, and only eight thrips were found on the densely shaded cacao between the end of September and mid-November. There was a significant negative correlation between populations and rainfall, notably with rainfall in the previous month. In general, thrips populations and the numbers of infested and damaged leaves decreased significantly with increasing shade, and as the percentage of nymphs in the population also did so, dense shade possibly restricts breeding.

DEBACH (P.). **The Necessity for an ecological Approach to Pest Control on *Citrus* in California.**—*J. econ. Ent.* **44** no. 4 pp. 443–447, 12 refs. Menasha, Wis., 1951.

The author points out that the development of the chemical control of pests that attack *Citrus* in California has been a response to immediate problems and that although such treatments have made it possible to produce commercial *Citrus* crops, the immediate need has led to the neglect of fundamental studies of natural factors affecting pest populations. In many cases, chemical treatments have not resulted in a final solution, and the repeated applications necessary to maintain control have sometimes intensified the problem [*cf. R.A.E.*, A **39** 337, 342-343]. Although chemical control measures are now taken as a matter of course by many growers, biological control has given promising results against several major pests, including *Aonidiella aurantii* (Mask.), *A. citrina* (Coq.) and *Paratetranychus citri* (McG.) in some untreated groves [*cf.* **35** 126; **39** 235, 236]. The possibilities of extending natural control into groves now receiving periodic chemical treatment are encouraging, and a knowledge of the adverse ecological factors affecting natural enemies may lead to methods of environmental modification that will favour them. These methods include overcoming a periodic lack of suitable host stages for parasites by field colonisation of the parasites at critical stages, colonisation of *Citrus* trees with the host to obtain a continuity of susceptible host stages or the use of alternative food-plants for the same purpose; the maintenance of alternative prey for general predators, possibly by the provision of suitable cover crops; limited modification of meteorological conditions, as by the use of cover crops and sprinkler-type irrigation to increase humidity; the control of ants and dust, both of which interfere with natural control; and the modification of chemical control to prevent its interfering with natural enemies.

RIPPER (W. E.), GREENSLADE (R. M.) & HARTLEY (G. S.). **Selective Insecticides and Biological Control.**—*J. econ. Ent.* **44** no. 4 pp. 448–459, 11 figs., 25 refs. Menasha, Wis., 1951.

The use of ordinary insecticides has been shown to lead to a rapid reinfestation of a treated crop in spite of high initial mortality and eventually to the

segregation of strains of pests resistant to the poison used [*cf. R.A.E.*, A **32** 333, etc.]. Suggestions made for preventing the latter have included frequent variation of the insecticide, increasing its tenacity, and the use of selective insecticides, defined as insecticides that are toxic to the pests but not to their natural enemies. These may be physiologically selective, in that they do not kill natural enemies at a concentration that is toxic to the pest, or ecologically selective, in that they can be applied to a part of the plant on which the natural enemies do not occur. Provided that sufficient numbers of the pest survive to maintain an effective population of natural enemies, the immediate effect of a selective insecticide is to enable enemies further to reduce the pest population, and the delayed effect is that the natural enemies prevent a rapid increase of the pest population, so that the intervals between treatments can be prolonged. Should the application of selective insecticides become widespread, the parasites and predators that attack pests at low levels of population density will become the most effective.

Various methods of using selective insecticides are discussed [*cf.* **32** 333; **38** 192]. They include coating particles of DDT with hemicelluloses so that they can be digested only by phytophagous insects possessing a hemicellulase. This method proved costly and difficult to apply and was abandoned in favour of systemic insecticides, which are taken up from leaves or roots by the sap stream of the plant and, to some extent, translocated in the plant [*cf.* **38** 192; **39** 166]. Schradan (octamethyl pyrophosphoramide) has been investigated more than any other systemic insecticide. Experiments in England are recorded in which it gave high mortality of *Brevicoryne brassicae* (L.) on brussels sprouts and *Tetranychus telarius* (L.) on hops in spray or soil treatments without injuring predators (Syrphid larvae and *Coccinella septempunctata* L. for the Aphid and *Blepharidopterus angulatus* (Fall.) for the mite) or *Diaeretus rapae* (Curt.) (*Aphidius brassicae* Marsh.), a parasite of the Aphid, exposed on the plants [*cf.* **38** 192]. Two other systemic insecticides, Isopestox [which contains bis(mono-isopropyl-amino)fluorophosphine oxide] and C.R.409, proved about as effective as schradan against the Aphid and mite. They caused high mortality of the beneficial insects for 64 hours when the plants were sprayed, but not later, although newly exposed Aphids were still being killed, owing to the absorption of the insecticide into the leaf. Soil treatment did not harm natural enemies. Treatments with systemic insecticides were effective against Aphids and mites for 3–6 weeks during the growing season and for much longer when the plants were less actively developing. Soil treatment with C.R.409 also controlled *Pseudococcus kenyae* Le Pelley on coffee in Africa without affecting predators.

Observations on the mortality of pests, chemical analyses and the use of the radio-tracer method showed that application of a systemic insecticide to the soil gave translocation upwards, that spray treatment of the stem or leaves gave translocation below and above the points treated, that absorption by leaves was best when they were just fully opened, that parts of the plant that were not present at the time of spraying, including seeds not then formed, became toxic through translocation from the sprayed older parts and that if seed was soaked or coated with a systemic insecticide, this was later translocated into the young plant [*cf.* **39** 167]. The duration of effectiveness is limited by decomposition of the insecticide when exposed to the enzymes of the plant. Decomposition of schradan was too rapid to be explained by mere hydrolysis; it occurred in 3–4 weeks in the growing season but was delayed when the plants were dormant, and spray applications made just before growth ceased produced lasting toxicity in the plant during winter. When schradan was applied to the soil, the plant caused decomposition of the compound as before, but was still absorbing it from the soil after 70 days, which indicates that decomposition is slower in soil than in growing plants. Investigations on the mode of decomposition are described.

For applying systemic insecticides in sprays, the normal high-volume apparatus is suitable, but important saving in water transport can be achieved by the use of a low-volume sprayer, as it has been shown that far less uniform coverage is necessary for systemic insecticides than for other materials. The plants absorb and distribute any surplus deposit, and it was found that a given amount of schradan is no more effective on beans and hops in 100 gals. per acre than in 4 gals. per acre.

ULLYETT (G. C.). **Insects, Man and the Environment.**—*J. econ. Ent.* **44** no. 4 pp. 459–464, 5 refs. Menasha, Wis., 1951.

The primary problems of economic entomology have an ecological background, and the methods employed in solving them should be based on consideration of the environment and the organisms that inhabit it as a whole. The activities of man cause great alterations in the environment extending over relatively large areas, and the use of potent insecticides causes catastrophic mortality on an extensive scale and of a type foreign to nature. Attempts to destroy injurious insects as completely as possible should be replaced by attempts to achieve a state of balance in which no organism develops to the detriment of its fellows or of the environment, such as commonly occurs when the environment is not disturbed. This would be unstable, but might be such that the fluctuations in it did not become of economic importance. Where natural control occurs in some degree, it should be made use of so far as possible and supplemented where necessary by artificial control measures. To do this effectively, an increase is required in basic knowledge of natural environments and of the interrelationships between the various biotic and abiotic components of them, and of the effects of poisons, not only on the various insects and other arthropods, but also on other animal life, plants and soil.

GRIFFITHS (J. T.). **Possibilities for better *Citrus* Insect Control through the Study of the ecological Effects of Spray Programs.**—*J. econ. Ent.* **44** no. 4 pp. 464–468, 2 graphs, 12 refs. Menasha, Wis., 1951.

The use of various spray materials on *Citrus* in Florida favours infestation by certain Coccids and mites [*cf. R.A.E.*, A **39** 11], but as over half the *Citrus* crop now produced there is used for canning and is therefore not reduced in value by external blemishes, it is thought that applications of some of these materials might be reduced or eliminated.

Citrus for the fresh-fruit market is sprayed with copper compounds for nutritional purposes and to control melanose, zinc as a nutritional element, sulphur to control the external blemishes caused by the rust mite [*Phyllocoptruta oleivorus* (Ashm.)], dinitro-o-cyclohexylphenol against the citrus red mite [*Paratetranychus citri* (McG.)] and oil or parathion against Coccids. It is primarily the inclusion of copper and zinc in the spray programme that necessitates the use of sprays against Coccids and mites, and for canning-fruit programmes, copper can be applied to the soil for nutritional purposes and the amount and frequency of zinc sprays probably materially reduced. Lead arsenate, which is applied to grapefruit to sweeten the fruit, has at times resulted in increased infestation by the Florida red scale [*Chrysomphalus ficus* Ashm.] for reasons that are not clear, but it can probably be included in cannery spray programmes with little deleterious effect on insect and mite control. *Phyllocoptruta oleivorus* causes russetting of the fruits and greasy spot on the foliage. The former is not known to affect internal quality, but the latter causes leaf-drop and may therefore result in decreased yield. The use of sulphur against this mite causes increase in *C. ficus*, the purple scale [*Lepidosaphes beckii* (Newm.)] and *Paratetranychus citri*, and its inclusion in the programme must

depend on the relative benefits derived from preventing early injury to fruit and leaf-drop due to greasy spot and the damage done by increasing infestations by the other pests. Oil emulsions and parathion are equally effective for scale control. Oil affects tree vigour adversely, and parathion has in some cases caused premature leaf drop and, when applied continuously, increases in *Coccus hesperidum* L., but any choice of treatment would depend on whether yield differences between the two could be demonstrated.

Field tests carried out for three years to find whether unsprayed Valencia-orange and seedy-grapefruit trees would produce as much fruit as those receiving a complete spray programme or sufficient sulphur dust to prevent fruit injury by *Phyllocoptruta* showed that there were no significant differences in yield or internal quality, that zinc deficiency was not a problem, that scales and *Paratetranychus* were least prevalent on the unsprayed plots and that some of the trees receiving sulphur dust needed treatment against scales during the third year. From these results it appears that reduced spray programmes are feasible for the production of fruit for canning.

BEARD (R. L.). **Chemical Activity Ratios in Relation to Species-Specificity.**—*J. econ. Ent.* **44** no. 4 pp. 469–471, 1 fig., 2 refs. Menasha, Wis., 1951.

It has been shown that differences among insects in susceptibility to toxicants are greater than can be explained by differences in effective routes of application [*R.A.E.*, A **38** 201], so that gross morphological barriers that might prevent toxicants from reaching their sites of action cannot alone explain species-specificity. This suggests that mode of action, as well as site of action, may be involved. Tests were therefore made to find whether a series of toxicants having, presumably, the same mode of action have the same proportionate effect on two unrelated insects.

In one test, eserine and a series of organic phosphorus compounds that are inhibitors of cholinesterase [*cf.* **38** 317] were tested for toxicity against adults of the milkweed bug, *Oncopeltus* [*fasciatus* (Dall.)], and larvae of the wax moth, *Galleria* [*mellonella* (L.)]. Solutions of the test compounds in olive oil were injected parenterally into the insects, the median lethal dosages were estimated, and the ratio of that for *Galleria* to that for *Oncopeltus* was found for each compound. The ratios for eserine, parathion, hexaethyl tetraphosphate, tetraethyl pyrophosphate, tetraethyl dithionopyrophosphate and tetraethyl monothionopyrophosphate were 1, 11, 20, 30, 9 and 60, respectively, and the differences were so great that it is concluded that chemicals that act on the same physiological system do not necessarily affect different insects to proportionate degrees [*cf.* **38** 317].

Since the differences might be due to differences in the ability of the insects to detoxify or eliminate the chemicals, a further test was made in which the elimination factor was avoided. Haemolymph withdrawn from larvae of *Galleria* and the Japanese beetle, *Popillia* [*japonica* Newm.], was exposed to air, and the effect of a series of inhibitors on its melanisation was observed. The method was to impregnate filter paper with the desired quantity of test chemical per unit area, apply a drop of the haemolymph to it, and put the paper in a moist chamber. After one hour, the colour of the haemolymph was compared with a series of standards and the degree of inhibition estimated by comparison with uninhibited controls. The ratios of the quantity of inhibitor required for 50 per cent. inhibition of melanisation in *Galleria* to the quantity for *Popillia* were calculated to be 6, 1,300 and 4 for thiourea, phenylthiourea and allylthiourea, respectively, and 100, 4, 50 and 1 for thioacetanilide, thioacetamide, sodium azide and sodium thioglycollate, and it is concluded from the wide differences that more is involved in species-specificity than specific differences in the quantity of the vulnerable substrate and the ease with

which a toxicant reaches the site of action. This has the important implication that increasing the permeating ability of an insecticide will not necessarily render it effective against insects that are hard to kill.

GERSDORFF (W. A.) & MITLIN (N.). **Joint toxic Action against House Flies in Mixtures of Parathion and its Methyl Homolog.**—*J. econ. Ent.* **44** no. 4 pp. 474–476, 6 refs. Menasha, Wis., 1951.

The relative toxicity of parathion, its methyl homologue (O,O-dimethyl O-p-nitrophenyl thiophosphate) and three mixtures of these compounds was determined by testing them against *Musca domestica* L. as sprays in refined kerosene by the turntable method [*R.A.E.*, B **26** 246]. The methyl homologue was 68 per cent. as toxic as parathion, and 1 : 4, 1 : 1 and 4 : 1 mixtures of parathion and its methyl homologue were, respectively, 72, 88 and 91 per cent. as toxic as parathion. The mortality percentages caused in one day by 100 mmg. per ml. of the two compounds and the three mixtures were 87·9, 55·9, 66·3, 72·2 and 83·6. The action of the compounds when applied jointly was identified as similar action [A **28** 200], since one of them could be substituted for the other in a constant ratio without altering the toxicity of the mixture.

KERR jr. (T. W.). **The chemotherapeutic Value of several Insecticides for Larvae of certain Leaf mining Insects.**—*J. econ. Ent.* **44** no. 4 pp. 493–498, 9 refs. Menasha, Wis., 1951.

An account is given of field investigations in Rhode Island in 1949–50 to determine the relative chemotherapeutic value of several insecticides when administered by means of foliage application and absorption. Materials other than nicotine sulphate were used as wettable powders, and all spray quantities are given per 100 U.S. gals. water. In order to obtain a reliable indication of value, leaf-mining insects of three species with larvae that develop wholly within the leaves of their food-plants were selected. Brief notes on their bionomics are included, and the results of the tests are shown in tables. Sprays containing 1 lb. actual aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanophthalene], DDT, BHC (benzene hexachloride) or lindane [at least 99 per cent. γ BHC] or 2·5 U.S. pints nicotine sulphate, all with a wetting agent, all gave some mortality of larvae of *Monarthropalpus buxi* (Lab.) when applied to box (*Buxus*). Aldrin was significantly less effective than dieldrin, but both were highly toxic and significantly better than any other material. Chlordan was ineffective. Aldrin and dieldrin at 1 lb. were highly effective against first-instar larvae of *Phytomyza ilicicola* Lw. (*ilicis* auct.) in leaves of American holly (*Ilex opaca*), with no difference between them ; chlordan and lindane at the same concentration had a considerably less but still significant effect.

Sprays of 1 U.S. pint nicotine sulphate, 0·25–1 lb. aldrin or dieldrin or 0·5–1 lb. chlordan or DDT were applied on different dates against first-generation larvae of *Fenusa pusilla* (Lep.) in leaves of grey birch (*Betula populifolia*). Aldrin and dieldrin were highly effective, dieldrin again being the better of the two, nicotine sulphate was only slightly less good, while chlordan was considerably less so and DDT almost ineffective. In a later test against the second generation, DDT was omitted and the order and degree of effectiveness of the other materials was unaltered. None of the treatments against the first generation afforded protection against the second in leaves produced later in the season.

It is considered that nicotine sulphate may reach the interior of the leaf by diffusion in aqueous solution through the cuticle and epidermis, by solution and

diffusion in the lipid phase through the cuticle and epidermis and by diffusion in the vapour phase through the stomata, and the chlorinated hydrocarbons by the second or third method or a combination of them, but regardless of the mode of penetration, the fact that some of the materials killed insects wholly enclosed by plant tissues entitles them to be placed in the category of chemotherapeutic agents.

Cox (J. A.). **Plum Curculio Control on Prunes.**—*J. econ. Ent.* **44** no. 4 pp. 499–504, 10 refs. Menasha, Wis., 1951.

The following is largely based on the author's summary. *Conotrachelus nenuphar* (Hbst.) is one of the most destructive pests of prunes and plums in Erie County, Pennsylvania, and lead arsenate and certain organic insecticides were compared for its control in 1949 and 1950. Sprays were applied on 17th and 24th May (shuck split and shuck fall) and 4th June in 1949 and on 29th May and 5th June (shuck split and shuck fall) and 12th June in 1950. Single applications were made in neglected orchards on 8th June 1949 and 15th June 1950 to test the effect on immature stages. All spray quantities are given per 100 U.S. gals. Lead arsenate at 2·5 lb. did not give satisfactory control, but BHC (benzene hexachloride) at 0·25 lb. γ isomer and parathion at 0·25 lb. both gave excellent control ; BHC was toxic to the immature stages but not to the adults, and parathion gave a high initial kill of adults but was less toxic to the immature stages than BHC. In 1950, ethyl p-nitrophenyl thionobenzenephosphonate (as EPN-300) at 0·27 lb. gave satisfactory control ; it gave a high initial kill of the adults and remained effective for 4–6 days, but was less toxic to the immature stages than BHC or parathion. An emulsion concentrate containing 33·4 per cent. of a mixture of parathion and its methyl homologue (1 : 4) of which the active ingredients are designated dialkyl nitroaryl thiophosphates (Metacide) at 1 U.S. pint was quite effective, with high initial kill of the adults, but soon lost its toxicity ; it appeared to control the immature stages. BHC, parathion or EPN-300 caused no injury to the fruits or foliage of prune, but three applications of Metacide injured the fruits.

Snapp (O. I.). **Plum Curculio Control with new organic Insecticides.**—*J. econ. Ent.* **44** no. 4 pp. 504–508, 3 refs. Menasha, Wis., 1951.

The results are given of further tests of organic insecticides for the control of *Conotrachelus nenuphar* (Hbst.) on peach in Georgia [*cf. R.A.E.*, A **38** 101] carried out in 1949–50. Most of the sprays were applied four times, at petal fall, shuck-off, two weeks later and four weeks before harvest. Wettable sulphur was added to all treatments on the last two dates, and hydrated lime and zinc sulphate to lead arsenate, which was applied only three times. Unless otherwise indicated, all materials were used as wettable powders, and spray concentrations are of active material per 100 U.S. gals.

Tests in which adults were caged on the branches of sprayed trees showed that newly emerged weevils of the first generation are more resistant to most insecticides than overwintered ones. Sprays containing 2–3 lb. 15 per cent. parathion or 1 lb. 15 per cent. parathion with 2 lb. lead arsenate killed practically all adults in 2–5 days, and the parathion maintained its effect for about ten days. Lindane [at least 99 per cent. γ BHC (benzene hexachloride)] and other forms of BHC with a high γ isomer content were much less effective than technical BHC at an equivalent concentration of γ isomer [*cf. loc. cit*]. Methoxy-DDT (methoxychlor) at 1 lb. and chlordan at 1 or 1·5 lb. killed all overwintered adults in 3–7 days and all those of the first generation within 13 days and showed fairly good residual effect, and aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] and

dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] at 0·5 lb. killed all adults in 3–4 days and showed considerable residual effect. EPN (O-ethyl O-p-nitrophenyl benzenethiophosphonate) at 0·54 lb. and a mixture of parathion and its methyl homologue (1 : 4) at 7·68 oz. 30 per cent. emulsion concentrate killed all adults in 2–5 days, and the former seemed to have exceptional residual value. Dilan (a mixture of 1,1-bis(p-chlorophenyl)-2-nitropropane and 1,1-bis(p-chlorophenyl)-2-nitrobutane (1 : 2)) gave inconsistent results at 0·5 lb. and poor results as a 25 per cent. emulsion concentrate at 1 : 600, but S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate at 0·5 lb. killed all adults in 2–4 days ; emulsions of the latter and of dimethyl-O-chloro-p-nitrophenyl thiophosphate gave good results against overwintered adults, but only fair results against those of the first generation. A formulation containing schradan (octamethyl pyrophosphoramide) was ineffective when applied to the trees or the ground and when branches were dipped in it. Lead arsenate gave a slow kill, which was accelerated by the addition of DDT.

When chlordan at 3 lb. or parathion at 1·5 and 2 lb. was applied to the soil at the rate of 1 U.S. gal. liquid per 6 sq. yards against the larvae, there was only 0·8, 8·3 and 5·3 per cent. adult emergence, respectively, and when parathion was applied at 2 lb. against the pupae there was only 1 per cent. ; observations indicated that the adults that emerged were affected by the treatment.

In large-plot tests, five applications (the last two weeks before harvest) of 0·45 lb. parathion gave almost perfect control of infestation at harvest and four of parathion or 1·5 lb. chlordan or a combination of two of 4 lb. BHC (6 per cent. γ isomer) and two of 2 lb. lead arsenate gave fairly good results ; three of 2 lb. lead arsenate gave poor control. Parathion and BHC gave much better control of infestation in dropped fruit than chlordan or lead arsenate alone. In small plots, there were no infested peaches on trees that received four applications of 0·5 lb. dieldrin or three of 0·45 lb. parathion and one of 0·54 lb. EPN ; 0·5 lb. aldrin applied four times and 0·45 lb. parathion applied 4–5 times gave good control ; and 1 lb. methoxy-DDT applied four times was as effective as 4 lb. BHC (6 per cent. γ isomer) and showed promise. Lindane was inferior to technical BHC at an equivalent concentration of γ isomer, and Dilan and fluoro-DDT (DFDT) were poor.

The flavour of ripe fresh peaches was affected by BHC and that of canned peaches by BHC and lindane. Most of the new insecticides caused no injury to the fruits or trees, but tetraethyl pyrophosphate applied as a fog by commercial aeroplanes caused heavy defoliation and some fruit injury. Values for the maximum residues of the various insecticides at harvest are shown in a table.

LATHROP (F. H.). **Sidelights on European Red Mite Control.**—*J. econ. Ent.* **44** no. 4 pp. 509–514, 2 graphs, 6 refs. Menasha, Wis., 1951.

For 10–15 years, the author observed that trees in well-sprayed apple orchards frequently suffered destructive infestations of the European red mite [*Paratetranychus pilosus* (C. & F.)], while adjoining unsprayed trees were uninfested, and in 1950 he carried out experiments on the direct and indirect effects of spray applications on apple on the mite and its natural enemies at Monmouth, Maine. Except for ground sprays, treatments were applied with a so-called liquid-duster. The dust was applied in the conventional manner. The other materials were applied as concentrate mist sprays in the liquid phase of the application. Before petal-fall, sprays of the sodium salt of dinitro-o-cresol were applied three times to the ground and dusts of bentonite three times to all the trees (with lead arsenate, lime-sulphur and water, respectively, in the liquid phase) in order to control scab [*Venturia inaequalis*]

so completely that fungicides could later be omitted from the sprays applied to some of the plots. At petal-fall (2nd June) and in various numbers of cover applications ending on 1st August, two series of trees received sprays of lead arsenate alone or with Karathane WP-25 (22·5 per cent. dinitrocaprylphenyl-crotonate with 2·5 per cent. other nitrogen derivatives of phenol, chiefly dinitrocaprylphenol), and two others received dusts of bentonite-sulphur and sprays of lead arsenate alone or with Aramite-15 (15 per cent. chloroethyl butylphenoxy methylethyl sulphite). The controls received no post-bloom treatment. The mite populations remained very low on the controls, but increased on the other plots, reaching a peak in mid-August. The increase was moderate for lead arsenate alone and was satisfactorily reduced by the addition of Karathane, but was very great for bentonite-sulphur and lead arsenate, and though it was reduced somewhat by the addition of Aramite, injury to the leaves was still severe. The degree of injury to the leaves was related to the loss of chlorophyll and affected the size, colour and sugar content of the fruits. Injury to the foliage resulted from the interaction of mite activity and spray damage and was aggravated by high temperature. Sulphur caused the greatest injury, but lead arsenate also caused some. Infection by scab was low on all trees that received sulphur and not high on those receiving Karathane. Predators, of which *Stethorus punctillum* Weise was the most abundant, gave important reductions of the mite on the controls and the trees sprayed with lead arsenate alone, but were not numerous on the other trees.

HOFMASTER (R. N.) & GREENWOOD (D. E.). **Control of the Two-spotted Mite on Strawberries.**—*J. econ. Ent.* **44** no. 4 pp. 514–519, 3 refs. Menasha, Wis., 1951.

Dusting sulphur gives good control of *Tetranychus bimaculatus* Harvey, the most serious pest of strawberries in south-eastern Virginia, under optimum conditions, but is comparatively ineffective at temperatures below 70°F., sometimes scorches the plants at temperatures above 80° and upsets the soil reaction when applied repeatedly. Newer acaricides were therefore tested in 1947–50.

In field tests in April 1947, a mixture of 1·5 per cent. dicyclohexylamine salt of dinitro-o-cyclohexylphenol and sulphur (1 : 1), referred to below as DN dust, 10 per cent. azobenzene dust and dusting sulphur gave 95, 93 and 83 per cent. control, respectively, hexaethyl tetraphosphate gave a high initial kill but failed to prevent rapid reinfestation, and parathion at 0·25 per cent. and benzene hexachloride at 1 per cent. γ isomer were ineffective. The azobenzene dust caused such severe scorching that it was not tested further, and DN dust caused some injury to the plants, but did not appear to retard growth to any extent.

In April 1948, dusts containing 0·5–2 per cent. parathion or 8 per cent. bis(p-chlorophenoxy)methane, DN dust and dusting sulphur, all applied at 40 lb. per acre, gave 96–97·9, 89·4, 96 and 90·9 per cent. reduction of a light population of mites four days after treatment, as compared with the control, and sprays of 1, 2 and 4 lb. bis(p-chlorophenoxy)methane in 100 U.S. gals. per acre gave 87·4, 88·8 and 94·1 per cent. The parathion and DN dusts were significantly better than all the other treatments except the highest concentration of the methane, but DN dust caused severe injury to blossoms and leaves. Ripening berries on plants dusted with 1 per cent. parathion showed a residue of 0·2 part per million parathion when harvested ten days later. Additional experiments after harvest showed that sprays of 1–2 lb. 15 per cent. parathion wettable powder or 0·5–1 U.S. pint 40 per cent. TEPP (tetraethyl pyrophosphate) in 75–100 U.S. gals. water per acre gave excellent control, whereas a dust

of 2 per cent. TEPP in pyrophyllite gave poor results unless used within 24 hours of mixing. In August, sprays of 2 lb. 25 per cent. wettable parathion or 1 U.S. pint 40 per cent. TEPP in 75 U.S. gals. water per acre gave more than 98 per cent. control and caused no foliage injury in extremely dry weather with temperatures rising to 95°F. TEPP killed few mites in the first 24 hours, but gave almost 99 per cent. mortality in 48 hours.

In February 1949, sprays containing 2 lb. 15 per cent. parathion wettable powder per 100 U.S. gals., alone or with a spreader, and one containing 1 U.S. pint 40 per cent. TEPP gave 50–70 and over 80 per cent. control of a heavy infestation when applied at 75–85 U.S. gals. per acre but showed little lasting effect. Control was poorer on the lower leaves, which were flattened over soil with a surface temperature of 40–45°F. In late March, sulphur dust at 40 lb. per acre and dusts containing 1 per cent. parathion or 2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite or 3 per cent. dinitrocaprylphenylcrotonate (Arathane) at about 35 lb. per acre gave 66·6, 88·2, 72·8 and 89·7 per cent. mortality in three days, as compared with 4·8 per cent. on untreated plots, but soon lost their effect, and several additional treatments were necessary to control mite development.

In January 1950, when temperatures were high and infestation heavy, sulphur at 50 lb. per acre and 1 per cent. parathion and DN dusts at 40 lb. gave 39, 74·3 and 60·2 per cent. mortality in one day, as compared with 1·1 for no treatment, and sprays of 2 lb. 15 per cent. parathion wettable powder, 2 U.S. pints 20 per cent. TEPP and a mixture of half these quantities, per 100 U.S. gals., applied at 75–85 U.S. gals. per acre, or one of 1 U.S. quart 75 per cent. dinitro-o-sec.-amylphenol (a herbicide that was observed in the winter of 1948–49 to affect the mites [*R.A.E.*, A **39** 123]) with 6·5 U.S. gals. kerosene per 100 U.S. gals. at 50 U.S. gals. per acre gave 53·1, 88·1, 65·2 and 98·4 per cent. mortality. Only DN dust and the herbicide had appreciable residual effect, with 70·1 and 99 per cent. reduction in mite population 30 days after treatment. A 1 per cent. parathion dust, alone or with 96 per cent. sulphur or 2 per cent. p-chlorophenyl p-chlorobenzenesulphonate, 3 per cent. of the last compound, sulphur, 2 per cent. EPN (ethyl p-nitrophenyl thionobenzenephosphonate) and 5 per cent. dinitrocaprylphenylcrotonate, applied at about 35 lb. per acre on 5th, 11th and 20th April, and sprays of 1 U.S. pint 75 per cent. dinitro-o-sec.-amylphenol, alone or with 32·5 U.S. gals. kerosene in 50 U.S. gals. water per acre, on 20th March, all more than doubled the yield. The crotonate dust and the sprays gave the greatest reductions in mites and the greatest increases in yield. The herbicide can be applied to strawberry plants only during the dormant period. When applied after harvest, when the weather was very hot and dry, 1 per cent. parathion with sulphur or the benzenesulphonate and 5 per cent. dinitrocaprylphenylcrotonate were outstanding for rapidity of action and lasting protection. The benzenesulphonate was slow in action, but gave promising prolonged control, and combinations of parathion and this material or sulphur gave significantly better results than any of these materials alone. Dusts containing 1 per cent. EPN or 4 per cent. S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate gave excellent initial control, but poor protection later, and sulphur and 5 per cent. dinitrocaprylphenylcrotonate caused severe and slight scorching, respectively.

Huffaker (C. B.) & Spitzer jr. (C. H.). **Data on the natural Control of the Cyclamen Mite on Strawberries.**—*J. econ. Ent.* **44** no. 4 pp. 519–522, 2 graphs, 2 refs. Menasha, Wis., 1951.

As a predacious mite, at first thought to be a species of *Iphidulus*, but recently identified as *Typhlodromus reticulatus* Oudm., has frequently been thought to control outbreaks of *Tarsonemus pallidus* Banks on strawberries in California,

population studies on the effect of the predator were carried out in 1950. One of each of four pairs of plots was dusted with parathion, which has little effect on *Tarsonemus* but eliminated the predator, and the populations of the two mites were estimated from leaf samples taken from all plots once a week between July and October.

Although the possibility of direct or indirect stimulation of the fecundity of *Tarsonemus* by parathion was not disproved, the preliminary results indicated a definite effect of the predator on the population of the pest. Populations of *Tarsonemus* rose on all plots, but whereas they continued to rise until the end of August on the dusted plots, they fell rapidly from about 16th–23rd August on the undusted ones and remained low for the rest of the season. There was a close association between the presence of the predator and this continued depression of the *Tarsonemus* population. Attempts are being made to rear *Typhlodromus* in large numbers in the insectary, with a view to using it in the field.

Roussel (J. S.), Weber (J. C.), Newsom (L. D.) & Smith (C. E.). **The Effect of Infestation by the Spider Mite** *Septanychus tumidus* **on Growth and Yield of Cotton.**—*J. econ. Ent.* **44** no. 4 pp. 523–527, 9 refs. Menasha, Wis., 1951.

The following is based on the authors' introduction and summary. With the increasing use of synthetic organic insecticides for the control of insects attacking cotton, injury by spider mites has become more frequent and more widespread, apparently owing to the destruction of predators. *Tetranychus bimaculatus* Harvey, *Septanychus tumidus* (Banks) and *S. texazona* McGregor all occur on cotton in Louisiana, and the effect of infestation by *S. tumidus* on the growth and yield of the crop were studied in a field-plot experiment at Baton Rouge during 1950. Sprays were applied to control other pests, reduce the predator population and prevent the establishment of mites in plots in which no infestation was desired.

Infestation by the mite caused 45 per cent. decrease in the amount of seed cotton produced, reduced vegetative growth as measured by the amount of dry matter produced, number of leaves per plant and size of leaves, and affected several characters of the seed and lint adversely. Examination of samples of bolls that developed at the first node of the seventh fruiting branch showed that there were reductions in the average number of seeds per boll and in the weight, viability and oil content of the seeds. Infestation had little effect on lint percentage, but caused a sharp decrease in the lint index (the weight in grams of the lint on 100 seeds) ; it also caused a reduction in the length and maturity of the fibres.

Davich (T. B.) & Apple (J. W.). **Pea Aphid Control with contact and systemic insecticidal Sprays.**—*J. econ. Ent.* **44** no. 4 pp. 528–533, 4 refs. Menasha, Wis., 1951.

The following is largely based on the authors' introduction and summary. Spray experiments were carried out in Wisconsin in 1949 and 1950 to find an insecticide to replace DDT for the control of *Macrosiphum onobrychis* (Boy.) (*pisi* (Kalt.)) on peas, since there was danger of contamination of milk from DDT residues on pea silage fed to dairy cattle. Materials other than systemic insecticides were used in emulsion sprays, and applications of them were made with a low-pressure weed sprayer at 15 U.S. gals. per acre in 1949 and 5–15 U.S. gals. per acre in 1950.

Parathion at 0·2 lb. per acre gave very high initial kills of the Aphid and resulted in relatively low populations for two weeks after application, and

paraoxon (its oxygen analogue), methyl-parathion (its methyl homologue), combinations of the latter with parathion, and O-(2-chloro-4-nitrophenyl) O,O-dimethyl thiophosphate were about as effective as parathion. A 20 per cent. emulsifiable concentrate of TEPP (tetraethyl pyrophosphate) applied to give 1 U.S. quart per acre gave good initial kill but very poor control after two weeks. Combinations of TEPP with DDT showed more prolonged toxicity because of the presence of DDT. The γ isomer of benzene hexachloride caused immediate kill, but permitted rapid re-establishment.

Materials found to be unsatisfactory against *M. onobrychis* included rotenone, 2-nitro-1,1-bis(p-chlorophenyl)propane, S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate, the diethoxythiophosphoric acid ester of 7-hydroxy-4-methyl coumarin and 1,1-bis(p-ethylphenyl)-2,2-dichloroethane.

Preliminary tests with a systemic insecticide, schradan (octamethyl pyrophosphoramide), showed that treatment with at least 1 lb. per acre when it was sprayed on the pea foliage and with 4 lb. per acre when it was sprayed on the soil before disking and sowing was needed for satisfactory control. There were indications that it was more effective when applied in 50 U.S. gals. spray per acre than in only 10 U.S. gals. per acre, but the difference was not significant [*cf. R.A.E.*, A **39** 377]. Less than 0·1 part per million of schradan was detected in canned peas from plots treated with 4 lb. of the toxicant per acre as a foliage spray or as a soil treatment before sowing. Where the foliage spray had been used, there were 2 p.p.m. schradan in the dried pea plants. In another test of systemic insecticides as foliage sprays, a trialkyl selenophosphate and a trialkyl thiophosphate applied at 0·25 lb. in 22 U.S. gals. per acre gave significantly better Aphid control than the same amount of schradan 16 days after application, but not 29 days after. Canned peas from the various plots showed no schradan, but 0·25 and 0·15 p.p.m. of the trialkyl selenophosphate and trialkyl thiophosphate, respectively. Dried pea plants, taken at harvest, had 1 p.p.m. trialkyl thiophosphate.

PATCH (L. H.), DEAY (H. O.) & SNELLING (R. O.). **Stalk Breakage of Dent Corn infested with the August Generation of the European Corn Borer.**— *J. econ. Ent.* **44** no. 4 pp. 534–539, 1 graph, 4 refs. Menasha, Wis., 1951.

The following is substantially the authors' summary of investigations on the effect of the August generation of the multiple-generation strain of *Pyrausta nubilalis* (Hb.) on 16 single-cross maize hybrids planted in late May 1944 near Lafayette, Indiana [*cf. R.A.E.*, A **38** 115]. Infestation from the June flight of moths was slight, and that from the August moths was augmented by the use of eggs produced in the laboratory [*cf. loc. cit.*].

An average increase of 10·1 borers per plant in the 16 hybrids caused an increase of 15·3 per cent. in the number of plants that broke below the ear, chiefly owing to an increase of 2·8 borers per plant within the stalks below the ear ; an increase of 38·9 per cent. in the number of plants that broke above the ear, mainly owing to an increase of about the same number of borers within the stalks above the ear ; and a decrease of 18·9 per cent. in the total yield including that due to dropped ears and ears on broken stalks that touched the ground and were considered impossible to harvest with a mechanical picker. Ears had fallen to the ground on seven of every 100 plants broken below the ear and one of every 100 plants not broken below the ear. The loss in yield as a result of the general reduction in the size of the ears was ten times as much as the loss in yield due to unharvestable ears, and the total reduction was 1·87 per cent. per borer per plant.

The hybrids differed in the amount of breakage caused by borers. A group of hybrids involving the line Ind. WF9, known to be resistant to *Diplodia*

stalk rot, broke less than a group involving line Ill. R4, known to be susceptible to *Diplodia*. Hybrids that showed averages of 2·2, 4·4, 6·8, 13 and 25 per cent. breakage below the ear in the presence of 0·5 borer per plant in the stalks below the ear showed 1·9, 3·3, 5·8, 7 and 9·7 per cent. additional breaks, respectively, for each additional borer, indicating that each of these caused progressively more increase in breakage. For an average of 3·3 borers per plant in the stalks below the ear, totals of 7·5, 13·6, 23, 32·6 and 52·2 per cent. of the plants, respectively, were broken below the ear.

When tested in single-cross hybrid combination, the inbred lines Ind. P8, Ia.L304A, Kan. K230 and Ia.L317 were apparently more resistant to shank infestation than the lines Ind. WF9, CI.187-2 and Ill. A, with line Ill. R4 somewhat less susceptible than WF9.

With the advance in the season, there was a pronounced change in the numbers of borers and their positions in the plants. Between 9th September and 5th October, there was a reduction of 5·3 borers per plant in situations outside the stalks, such as in the ears and behind leaf sheaths, and situations inside the stalks above the ears, whereas there was an increase of 1·3 borers per plant inside the stalks below the ears. The difference of 4, or 40·4 per cent. of the total borers on 9th September, represented individuals that had disappeared from the plants, but it is believed that before they did so, they materially reduced the yield of grain by feeding on the leaf sheaths and other leaf tissue.

DOMINICK (C. B.). **Tests with Insecticides for Hornworm Control on Tobacco.**— *J. econ. Ent.* **44** no. 4 pp. 539–541, 2 refs. Menasha, Wis., 1951.

The results are given of further tests on the control of *Protoparce sexta* (Johan.) and *P. quinquemaculata* (Haw.) on tobacco in Virginia [*cf. R.A.E.*, A **38** 507], carried out in 1950. Against the first generation, the first application was made on 11th June, when eggs and first-instar larvae were first observed, and the second on 26th June ; plant injury was estimated on 29th June. *P. quinquemaculata* was the more numerous. The percentage of plants injured was reduced from 45·5 for no treatment to 2·5, 4, 5·5 and 26·5 by dusts containing 5 per cent. DDT, 5 per cent. Dilan (a 1 : 2 mixture of 2-nitro-1,1-bis(p-chlorophenyl) propane and 2-nitro-1,1-bis(p-chlorophenyl)butane), 1 per cent. dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] and 5 per cent. heptachlor [1(or 3a),4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-endomethanoindene], used at 8 lb. per acre in the first application and 15 lb. in the second, and to 6 and 9 by sprays in which 50 per cent. DDT wettable powder and 15 per cent. dieldrin wettable powder were applied at 0·5 lb. per acre at the first application and 1 lb. at the second. The plants were also infested by budworms, mostly *Heliothis armigera* (Hb.), and although the treatments were not timed for their control, all but the dieldrin spray reduced the injury by them. In another test, two applications of 40 per cent. toxaphene at 1 and 2 lb. per acre in a spray and dusts containing 10 per cent. DDD (TDE) [dichlorodiphenyldichloroethane] or toxaphene or 5 per cent. Dilan at 8 and 15 lb. per acre reduced the percentage of plants injured from 42 to 1·5, 2, 3 and 3·5 and gave good control of budworms.

As *Protoparce* spp. and *Myzus persicae* (Sulz.) are often injurious to tobacco at the same time, combined dusts were applied at 15 lb. per acre against these pests on 5th July, when *P. quinquemaculata* was the predominant hornworm, the larvae were mainly in the fourth and fifth instars, and there was a moderate to heavy Aphid population. Dusts of 5 per cent. DDT with 1 per cent. parathion, 10 per cent. toxaphene with 1 or 0·5 per cent. parathion and 1 per cent. parathion alone gave 96·1, 94·4, 93·3 and 53·3 per cent. reduction of *Protoparce* and 99·7, 99·3, 98·6 and 99·9 per cent. reduction of Aphids in two days, as

compared with no treatment, and 10 per cent. toxaphene alone gave 91·6 per cent. reduction of *Protoparce*.

In a test against the second generation of *Protoparce*, dusts were applied on 16th August at about 20 lb. per acre, when the larvae present were in all instars and largely *P. sexta*. Counts made two and four days later showed 97·4 and 100 per cent. reduction by 10 per cent. DDD, 91·9 and 100 by 5 per cent. DDD, 96·9 and 98·9 by 5 per cent. Dilan and 94·2 and 97·1 by 10 per cent. toxaphene. In another test in which dusts were applied at 25 lb. per acre on 24th August, when 90 per cent. of the larvae were *P. sexta*, 10 and 5 per cent. DDD, 5 per cent. Dilan and 10 per cent. toxaphene gave 96·7, 95·6, 96·3 and 94·1 per cent. reduction after two days and 100 per cent. after four, and 90 per cent. cryolite gave 63·7 per cent. after two days and 90 after four.

FILMER (R. S.) & GINSBURG (J. M.). **Effectiveness of Airplane Applications of Insecticides and Poison Baits for Control of Armyworm and Insecticide Residue recovered at Harvest.**—*J. econ. Ent.* **44** no. 4 pp. 542–546, 6 refs. Menasha, Wis., 1951.

A severe outbreak of *Leucania* (*Cirphis*) *unipuncta* (Haw.) occurred in central and southern New Jersey in the summer of 1950. The larvae cut off the heads of nearly mature barley and oats and fed on the lower leaves of wheat and on weeds growing in grain fields. Attempts at control with insecticides applied by aeroplane showed that tetraethyl pyrophosphate was not satisfactory and that DDT and toxaphene applied in 10 per cent. dusts at 25 lb. per acre gave a fair kill of the young larvae and stopped the older ones from feeding for a few days ; lower concentrations at the same rate of application were ineffective. Both acted slowly and caused little mortality for the first 72 hours and neither prevented head-cutting of barley. In a barley field, 1 per cent. parathion gave immediate kill of the younger larvae and stopped the older ones from feeding for 1–2 days, but did not eliminate head-cutting.

Poison baits were the only treatments that gave immediate control and stopped the cutting of barley heads. A standard bait consisting of 1 lb. paris green or 1·25 lb. toxaphene, 25 lb. bran, and 2 U.S. quarts molasses, with 1–2 U.S. gals. water, distributed by hand, and a modified one in which the amounts of molasses and water were reduced to 1 U.S. quart and 0·75 U.S. gal., respectively, applied by aeroplane, both gave control in 24–72 hours. Toxaphene gave adequate control at the rate of 1·25 lb. per acre in the bait, and its ineffectiveness in the dust may have been due to light rainfall for several days, which did not affect the baits.

Chemical analysis of fresh plant material at harvest showed that barley dusted with DDT or toxaphene about a week before had appreciable insecticide residues on the grain and straw, whereas barley treated with poison baits a week before had only slight residues. Wheat dusted with DDT or toxaphene about a month before harvest and subjected to 3–7 ins. of rain had little residue.

WEINMAN (C. J.) & DECKER (T. C.). **The Toxicity of eight organic Insecticides to the Armyworm.**—*J. econ. Ent.* **44** no. 4 pp. 547–552, 17 refs. Menasha, Wis., 1951.

The following is based on the authors' summary. An account is given of laboratory tests carried out in Illinois in 1950 to determine the dosages of eight organic insecticides giving 50 and 99 per cent. mortality of armyworms [*Leucania unipuncta* (Haw.)] by contact and by stomach action. In order to relate dosage and mortality accurately, it was necessary to divide the data into groups based on four arbitrary weight classes of larvae, as larvae of widely

varying sizes from the same field did not respond in the same way to the same insecticide, even though the dosage was always related to the weight of the individual insects.

When the dosages giving 50 per cent. mortality were considered, parathion showed the highest contact toxicity, followed in order by dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy - 1,4,4a,5,6,7,8,8a,-octahydro - 1,4,5,8-diendomethanonaphthalene], Dilan (an eutectic mixture of one part 2-nitro-1,1-bis(p-chlorophenyl)propane and two parts 2-nitro-1,1-bis(p-chlorophenyl)butane, aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], lindane [at least 99 per cent. γ benzene hexachloride], toxaphene, chlordan and DDT. For stomach action, the order of toxicity was the same, except that DDT was more toxic than chlordan. Regression coefficients were calculated for each set of data so that the dosages causing 99 per cent. mortality could be predicted with some accuracy. The ratio of the median lethal dosage to this, which indicates the slope of the dosage-mortality curve, showed a considerable variation among the several materials ; dieldrin, lindane, parathion and aldrin showed the flattest slopes for contact effect, and toxaphene and dieldrin for stomach action. Parathion gave the fastest kill of larvae, with Dilan, lindane and DDT following in that order.

Ball (H. J.) & Beck (S. D.). **The Role of Circulatory and Nervous Systems in the toxic Action of Parathion.**—*J. econ. Ent.* **44** no. 4 pp. 558–564, 7 refs. Menasha, Wis., 1951.

Tests in which females of *Periplaneta americana* (L.) were treated topically with parathion (dissolved in acetone) showed that there was a direct relation between the distance of the treated area from tissue of the central nervous system and the time required for knockdown, but no correlation between cuticle thickness and knockdown time. Since insects treated over the dorsal blood-vessel had the longest knockdown time, it appeared that blood was not the only mechanism involved in the movement of the toxic principle of parathion [*cf. R.A.E.*, A **39** 14]. The possibility that removal of a part of the nerve system might delay the reaction of the cockroach to the insecticide was examined. Interrupting the ventral nerve cord by burning in the first, second or third abdominal sternites increased the time between treatment on the third to fifth segments and knockdown, and the time was further increased when the number of burnt areas was increased. The same increase in knockdown time was observed when other nerves between the treated area and central nerve tissue were cut or burnt. Tests in which males were treated topically between the sixth and seventh sternites over the ventral nerve cord and sections of nerve cord were removed immediately before treatment or 5, 10 or 20 minutes after it showed that knockdown time decreased with the increase in time between treatment and removal of nerve tissue.

When nerve, muscle or fat tissue from cockroaches was homogenised and put in parathion emulsion for 12 hours, washed and rehomogenised with small aliquots of benzene to extract the absorbed parathion, the relative knockdown times of adults to which the extracts were applied indicated that nerve tissue absorbs parathion in greater amounts than fat or muscle tissue. The accumulation of parathion in the central nervous system and in other tissues of cockroaches killed at the first appearance of symptoms after topical application was therefore investigated. Chemical analysis and bioassay of benzene extracts of the ventral nerve cords showed no significant amounts of parathion, which suggested that it may be metabolised in nerve tissue, but analysis of extracts of the foreguts showed that they were removing parathion from the blood and that the amount of parathion present was directly related to the time between treatment and dissection. Examination of blood removed

from treated insects 15 minutes after treatment showed that it carried small amounts of parathion and might be responsible for the continuous movement of small amounts of parathion from the point of application to the foregut, and when parabiotic connections were made between two cockroaches with the blood as the only tissue contact, parathion applied topically to one insect was detectable in the other at knockdown, giving final proof that the blood was one mechanism for its translocation.

It is concluded that both the central nervous system and the blood were active in translocating the toxic principle of parathion (probably some metabolite) in the insect body, the former being the more effective.

DITMAN (L. P.) & LLOYD (G. W.). **Timing Treatments for European Corn Borer Control.**—*J. econ. Ent.* **44** no. 4 pp. 564–566, 6 refs. Menasha, Wis., 1951.

Experiments were carried out in Maryland in 1949 and 1950 on the relation of the development of sweet-maize plants and oviposition by the European corn borer [*Pyrausta nubilalis* (Hb.)] to the timing of single sprays against the larvae. A spray of 2 lb. 50 per cent. DDT wettable powder per 100 U.S. gals. was applied to different plots at a rate of 200 U.S. gals. per acre when the plants were in the whorl stage and at successive intervals of 7–10 days, no plot receiving more than one application. On an early variety, planted in April–May and harvested in July 1949, the earliest spray gave the greatest reduction of larvae in the stalks, and sprays during the silk stage of those in the ears ; all sprays gave more than 50 per cent. control of larvae in the stems in 1950, when ear infestation was too low for reliable results. On a mid-season variety planted in June and harvested in August–September, the application at full silk gave the greatest reduction of larvae in ears and stalks in 1949, when no egg-masses appeared before the silking stage, and the spray at the early silk stage in 1950, when no egg-masses appeared after it. On a late variety, planted in July and harvested in September 1949, the most effective treatment was that made when the first silks were appearing.

There appeared to be a definite relation between the state of development of the maize plant and the best time of treatment, which was usually during the early silk stage, but none between the time of heaviest egg deposition and effectiveness of treatment at the low levels of infestation prevailing.

RUTSCHKY (C. W.). **Corn Earworm Control Experiments in Pennsylvania in 1950.**—*J. econ. Ent.* **44** no. 4 pp. 567–569. Menasha, Wis., 1951.

Owing to the increase in the cultivation of sweet maize in south-eastern Pennsylvania and the recent mild winters, *Heliothis armigera* (Hb.) has for several years caused extensive damage to the crop. In tests of seven insecticides in 1950 for its control, dusts were applied at 40 lb. per acre, sprays at about 50 U.S. gals. per acre and oil injections into the ears at 0·5 cc. per ear. Damage was estimated by examination of the ears at harvest, which showed that infestation by *Laphygma frugiperda* (S. & A.) and *Pyrausta nubilalis* (Hb.) was light and had little effect on ear quality.

In the first test, dusts containing 5 per cent. DDT or DDD (TDE) [1,1-di(p-chlorophenyl)-2,2-dichloroethane], 1 per cent. parathion or 7 per cent. 1,1-di(p-ethylphenyl)-2,2-dichloroethane(Q-137), applied on 17th August (nine days after the first silks appeared) and on 19th and 21st August, increased the percentage of uninfested ears from 30 to 59, 53, 52 and 38, respectively, and water emulsions containing 2 per cent. DDT or DDD or 1·5 per cent. Q-137 applied on 17th and 21st August increased it to 71, 61 and 65. In the second, mineral oil containing 1 per cent. DDT, methoxy-DDT (methoxychlor), Q-137

or DDD, injected into the ears on 31st August, four days after the field was in full silk, increased the percentage of uninfested ears from 0·5 to 81, 29, 22 and 20, respectively.

In a third test, in which infestation was severe, dusts were applied on 1st September (seven days after the field showed silks) and on 4th, 6th and 8th September, mineral-oil emulsions (prepared from mineral oil and emulsion concentrates) on 2nd and 6th September, water emulsions (prepared from emulsion concentrates) and wettable-powder sprays on 2nd, 5th and 8th September and mineral-oil injections on 7th September. All methods of treatment gave good control ; emulsion sprays of mineral oil and an insecticide were the best, followed in order by water emulsions, mineral-oil injections, dusts and wettable-powder sprays. Mineral-oil emulsions containing 7·5 per cent. mineral oil and 2 per cent. DDT, DDD or methoxy-DDT increased the percentage of uninfested ears from 8 to 86, 77 and 73, respectively, and the percentage of marketable ears from 55 to 95, 95 and 92, water emulsions containing 2 per cent. DDD increased these percentages to 74 and 92, and 5 per cent. DDT dust increased them to 77 and 93 ; Q-137 in all forms of treatment, dichloroethyl ether in a mineral-oil injection, parathion, DDD and *Ryania* dusts and a parathion wettable-powder spray were less effective.

HAWKINS (J.). **Importance of Time of Application of DDT Sprays in Control of European Corn Borer.**—*J. econ. Ent.* **44** no. 4 pp. 569–571, 2 graphs, 3 refs. Menasha, Wis., 1951.

As preliminary experiments in Maine showed that time of application is an important factor in the control of the European corn borer [*Pyrausta nubilalis* (Hb.)] on maize with insecticides [*cf. R.A.E.*, A **38** 202], attempts were made in 1950 to increase the effectiveness of the treatment by more accurate timing. Single sprays of DDT were applied, and standard procedure was followed, except that the rate of application was increased in order to secure satisfactory run-off at the base of the plants.

The following is based on the author's summary of the results. Single applications of DDT sprays gave 80 per cent. or more control if applied when 13–52 per cent. of the eggs had hatched and 87–99 per cent. of the moths had emerged, but one applied when about 4 per cent. of the eggs had hatched and 71 per cent. of the moths had emerged was less satisfactory. Cumulative moth-emergence curves appeared to be promising for timing applications. In central Maine, these are probably unnecessary before the maize has reached the late-whorl stage. If it is in the late-whorl or early, mid- or late green tassel stage when moth emergence has reached more than 87 per cent., single applications of DDT sprays should control 80–85 per cent. of the borers present.

GAINES (J. C.) & MISTRIC jr. (W. J.). **Effect of Rainfall and other Factors on the Toxicity of certain Insecticides.**—*J. econ. Ent.* **44** no. 4 pp. 580–585, 2 graphs, 3 refs. Menasha, Wis., 1951.

In further investigations at College Station, Texas, on the effect of climatic factors on the toxicity of organic insecticides to pests of cotton [*cf. R.A.E.*, A **39** 163, etc.], the effect of rainfall on sprays and dusts used against *Anthonomus grandis* Boh., *Alabama argillacea* (Hb.) and *Estigmene acraea* (Dru.) was tested in 1950. All sprays were prepared from miscible-oil concentrates. In a test made in August, sprays of toxaphene, aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] and dieldrin [1,2,3,-4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] were more effective against *Anthonomus* than the corresponding dusts when applied in the laboratory and greenhouse and the sprays

were considerably more effective there than when applied in the field. Since temperatures did not vary much in the laboratory, greenhouse or field, it is assumed that the wider range in relative humidity, sunshine, wind and dew or a combination of these factors reduced the toxicity of the three compounds in the field ; aldrin was more affected than dieldrin or toxaphene. The application of 0·5 in. simulated rain did not affect the toxicity of sprays of dieldrin and toxaphene, applied in September and October, but greatly reduced that of aldrin. When three toxaphene sprays prepared from concentrates containing different emulsifiers were compared at similar rates under conditions of no rain and with 0·5 in. simulated rain applied soon after the sprays were dry, there were no significant differences in toxicity to the weevil. The dosages of toxaphene, aldrin and dieldrin required to give comparable kill increased as the season progressed, apparently owing to changes in the physiology of the weevil, as temperature and humidity did not differ greatly.

Against third-instar larvae of *Alabama*, sprays of toxaphene, γ BHC (benzene hexachloride) and 1,1-di(p-ethylphenyl)-2,2-dichloroethane were equally effective, and the first two were more effective in sprays than in dusts. The toxicity of the toxaphene and BHC sprays was reduced to some extent by 0·5 in. simulated rain, but these insecticides are generally used at such high rates against other cotton pests that they would probably remain effective against *Alabama* after at least 0·5 in. rain. The simulated rain rendered the dusts ineffective.

The toxaphene sprays prepared from the three concentrates showed significant differences in toxicity to third-instar larvae of *Estigmene*, and 0·5 in. simulated rain reduced the toxicity of the two more effective, though not enough to make them useless. Dieldrin and aldrin sprays were much more toxic to the larvae than toxaphene sprays, and dieldrin was slightly more effective than aldrin. The toxicity of aldrin was very greatly reduced by rainfall, but that of dieldrin only slightly. Simulated rain greatly reduced the toxicity of mixed dusts of toxaphene and sulphur, and this result was little affected by the addition of oil or a commercial adhesive.

Davis (E. W.) & Landis (B. J.). **Life History of the Green Peach Aphid on Peach and its Relation to the Aphid Problem on Potatoes in Washington.**—*J. econ. Ent.* **44** no. 4 pp. 586–590, 1 graph, 8 refs. Menasha, Wis., 1951.

Myzus persicae (Sulz.) causes moderate damage to potato in central Washington each year, but was not considered a major pest there until 1938, when the leaf-roll disease, of which it is a vector, occurred in outbreak proportions [*cf. R.A.E.*, A **33** 39]. Observations made in several potato districts in the State showed that the Aphid appeared on potato earlier in the season and that losses from leaf-roll were greater at Yakima than in any other district, indicating that there was a greater abundance of satisfactory winter food-plants there than elsewhere. Patch concluded that peach was the true winter food-plant in the United States [*cf.* **14** 255], and there are few peach trees in any potato district of Washington except the Yakima Valley, where about 8,000 acres of potatoes are grown in close proximity to 6,000 acres of peach. In view of this, investigations were made on peach in 1949 to determine the time of production of the winged spring-migrants that infest potato and spread the disease.

The winter eggs hatched in February and early March, and both winged and wingless Aphids were produced in each generation on peach from the third onwards ; usually less than half were winged, and these did not reproduce successfully when caged on peach. Aphids appeared in potato fields near peach orchards within a few days after the first alates were observed on peach, but reached distant fields more slowly and did not give rise to such large populations in these. Fundatrices and 14 subsequent agamic generations were reared in

small celluloid cages on peach trees at Yakima between 4th March and 2nd September. The average length of life of the fundatrices was 49·5 days, and they produced an average of 73·1 young each. The average length of life of the agamic generations varied from 37·6 days for those produced in April to 15·2 days for those produced in August, and the maximum number of Aphids produced per female was 132 in the spring, 55 in June and 10 in August. An average of 27·4 nymphs per Aphid was produced by 292 Aphids during the season.

Chamberlain (W. F.). **Pre-silking Sprays to control Corn Earworm and Fall Armyworm.**—*J. econ. Ent.* **44** no. 4 pp. 590–592, 5 refs. Menasha, Wis., 1951.

Developments of the use of sprays containing oil and an insecticide for the control of *Heliothis armigera* (Hb.) on sweet maize [*cf. R.A.E.*, A **38** 63, etc.] have resulted in the recommendation of a spray of 3 quarts 25 per cent. emulsifiable DDT and 2·5 gals. light white oil per 25 gals., applied with a fine spray nozzle at 25 U.S. gals. per acre 2–3 times at intervals of 2–3 days from the time when about 10 per cent. of the silks are showing. In South Carolina, this treatment is effective on spring-planted maize, but not on that planted in summer, and experiments were therefore carried out to improve the programme so as to ensure control of *H. armigera* and *Laphygma frugiperda* (S. & A.) on summer-planted maize. Sprays containing 3 quarts 25 per cent. emulsifiable DDT, methoxy-DDT (methoxychlor) or Dilan [a 2 : 1 mixture of technical 2-nitro-1,1-bis(p-chlorophenyl)butane and 2-nitro-1,1-bis(p-chlorophenyl)-propane], 1 quart 75 per cent. emulsifiable chlordan or 1·2 quarts 60 per cent. emulsifiable toxaphene, all mixed with 2·5 gals. light mineral oil and diluted with water to make 25 gals., were applied at the rate of 25 U.S. gals. per acre. Sprays of DDT and Dilan, applied on 3rd August, when about 10 per cent. of the maize was in silk, and on 5th, 8th and 12th August, on 5th, 8th and 12th August only or on 8th and 12th August only all gave unsatisfactory control of both insects, with 67–97 per cent. infestation ; infestation began before the silks appeared. On a later planting, chlordan, Dilan, methoxy-DDT and DDT sprays were applied on 28th and 30th August, before the silks appeared, and on 1st and 4th September, after silking, on 1st and 4th September only, on 1st and 4th September and also on 10th, 12th, 14th and 17th September, after some silks were brown, or on all eight dates. With all the materials but chlordan, the addition of the pre-silking sprays to the regular programme reduced infestation ; Dilan and DDT were much superior to the other materials, giving excellent control, and a single test indicated that toxaphene was probably as good. Methoxy-DDT and chlordan were not effective, and post-silking sprays of any material were of little value. All the sprays caused some scorching.

Observations on the course of infestation by *H. armigera* on tomato during the season showed that there was a distinct correlation between a drop in infestation of the young tomato fruits and the period of silking of sweet and field maize. A later rise in infestation resulted from an increase in the moth population, so that even though maize was still in silk, increasing numbers of eggs were laid on tomato.

Elmer (H. S.), Ewart (W. H.) & Carman (G. E.). **Abnormal Increase of *Coccus hesperidum* in *Citrus* Groves treated with Parathion.**—*J. econ. Ent.* **44** no. 4 pp. 593–597, 6 refs. Menasha, Wis., 1951.

Since the introduction of parathion in 1947, there have been abnormal increases in populations of *Coccus hesperidum* L. in many but not all Californian *Citrus* groves treated with it, owing to the resistance of the Coccid to this

material and the susceptibility of its parasites [*cf. R.A.E.*, A **39** 337]. The increases have been characterised by the occurrence of the Coccid on the leaves and small branches throughout the trees, unattended by ants, with the greatest numbers on branch terminals touching the ground ; in untreated groves, they are normally found in colonies restricted to occasional branches and are almost always attended by ants.

To obtain information on the relation between parathion treatments and increases in *C. hesperidum*, surveys were made in 1949 and 1950 in plots and groves in which parathion had been applied against other Coccids. Spray quantities are given as actual parathion in a 25 per cent. wettable powder per 100 U.S. gals. unless otherwise stated.

In one grove, treated on 15th July 1947, increasing the concentration of parathion from 0·25 to 0·625 lb. caused a great increase in the population of *C. hesperidum* a year later, whereas increasing it from 0·625 to 0·75 lb. resulted in no further increase. An additional application of 1 lb. parathion in July 1948 to trees that had received 0·25 or 0·375 lb. in July 1947 resulted in considerable scale increases by November 1948. Populations did not increase on trees receiving either a spray of parathion, DDT and kerosene or one of light-medium oil containing rotenone. Trees sprayed on 10th June 1949 with 0·25 or 0·375 lb. parathion showed no significant increases in scale population on 22nd August and 22nd September 1949, but 0·5 lb. parathion resulted in a relatively large number of scales, and trees sprayed on 10th June and again on 3rd August 1949 with 6 oz. or 1 lb. technical parathion per 100 U.S. gals. had increased infestation on 22nd September. The population in this grove was greatly reduced by entomophagous insects by 17th November. Sprays of 1·25–2 lb. parathion applied by a spray-duster at 100 U.S. gals. per acre caused slight increases in *C. hesperidum*, but greater increases followed treatment with 0·125–0·375 lb. parathion applied at 2,000 U.S. gals. per acre with a normal high-pressure sprayer. The addition of 1 per cent. light-medium oil to sprays of 0·25 lb. parathion, applied on 18th May 1949 halved the increase in scale populations by 25th October and eliminated it by 16th December.

On plots receiving sprays of 1 lb. parathion in 1948 and 1949, much the greatest populations of *C. hesperidum* in 1950 occurred on those treated in April, June and August of both years and the lowest on those treated only in February each year. Parasites controlled the scales in all plots by 10th July 1950.

Plots sprayed with parathion, paraoxon [diethyl p-nitrophenyl phosphate], O,O-dimethyl S-(2-oxo-2-ureidoethyl)-dithiophosphate [also known as S-mercaptoacetylurea O,O-dimethyl dithiophosphate (**39** 12)], S-carbamylmethyl O,O-dimethyl dithiophosphate, and ethyl p-nitrophenyl thionobenzene-phosphonate (EPN) in 1949 all showed appreciable increases in populations of the scale, which at comparable dosages of toxicant were greatest for paraoxon. Aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] and dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,-5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] caused slight increases, but DDT, DDD (1,1-dichloro-2,2-bis-(p-chlorophenyl)ethane), methoxy-DDT (methoxychlor), fluoro-DDT (1,1,1-trichloro-2,2-bis-(p-fluorophenyl)ethane) and cubé root had no effect.

Iranian Locust Control.—*J. econ. Ent.* **44** no. 4 p. 597. Menasha, Wis., 1951.

Emergency aid extended by the United States to Persia for the control of locusts in 1951 included eight small aeroplanes equipped for distributing sprays, nine pilots, one mechanic and the services of W. B. Mabee as technical adviser. Over 53,000 acres of crops in 18 localities were treated at 1 U.S. gal. per

acre with a spray of aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] in diesel oil at 2 oz. per U.S. gal., and complete mortality of locusts was obtained in four days. Treatment of swarms of adults that had settled for the night was particularly effective.

EWART (W. H.), ELMER (H. S.) & GUNTHER (F. A.). **Parathion Treatments for the Control of Citricola Scale on *Citrus* in California.**—*J. econ. Ent.* **44** no. 4 pp. 598–603, 15 refs. Menasha, Wis., 1951.

Since the insecticidal treatments used against *Coccus pseudomagnoliarum* (Kuw.), a major pest of commercially-grown *Citrus* in the warm semi-arid interior valleys of California [*cf. R.A.E.*, A **33** 98 ; **34** 25], are not completely satisfactory, new insecticides have been tested in recent years. Parathion gave outstanding control, and the results are summarised of experimental applications of this compound in commercial navel or Valencia orange groves in central and southern California in 1947–50. Sprays prepared from a wettable powder containing 25 per cent. parathion were applied as high-volume sprays at the rate of 25–35 U.S. gals. per tree with the usual high-pressure spray equipment or as low-volume sprays at 100–200 U.S. gals. per acre with a spray-duster (a multi-nozzled air-blast type of machine designed to apply dusts or low-volume sprays to *Citrus*), and dusts containing 1 or 2 per cent. parathion in an inert diluent or sulphur at 100 lb. per acre with the spray-duster. Spray quantities given are of actual parathion. To conform with standard commercial practices, applications were made between late July and late October, when hatching was over, in late winter or early spring (February and early March), when the scales were slightly larger, and during the early part of the hatching period (late April to early June), when adults and newly hatched scales were present.

During the first of these periods, high-volume sprays containing 1–4 oz. parathion per 100 U.S. gals., low-volume sprays at 12–24 oz. parathion per acre and the dusts all gave very good control, with the dusts the least effective. The high-volume sprays were slightly better than the low-volume ones, but the results with the latter were promising, since such sprays cost 50–80 per cent. less than the usual spray and fumigation treatments. Parathion residues averaged less than 0·5 part per million of the fresh weight of the peel of ripe navel and Valencia fruits at harvest (1–3 and 6–8 months after treatment, respectively). The unusual susceptibility of small scales to parathion was shown by the killing of these on untreated trees adjacent to treated areas, apparently owing to the drifting of spray materials and the toxicity of parathion vapour.

During late winter and early spring, high-volume sprays containing 1, 2 and 4 oz. parathion per 100 U.S. gals., low-volume sprays at 1–2 lb. parathion per acre and the dusts all much reduced the scale population, but only the first gave satisfactory commercial control ; the three concentrations were equally effective, and the parathion residues recovered from the peel of Valencia oranges at harvest (3–5 months after treatment) averaged 0·4, 0·7 and 1·3 p.p.m., respectively.

During the early hatching period, single applications of high-volume sprays containing 4–16 oz. parathion per 100 U.S. gals. gave satisfactory control, with residues of 0·1–0·2 p.p.m. parathion in the peel of navel oranges at harvest (7–8 months later), but single treatments with the dusts or low-volume sprays at 1·5–3 lb. parathion per acre did not, though they reduced the scale population considerably. Two applications of low-volume sprays at 1·5 lb. parathion per acre, the first at the beginning of hatching and the second 2–4 weeks later, gave good control, but two applications of the dusts were still insufficient. The dusts mixed with sulphur were the more effective. Some of the treatments were followed by increases in *Coccus hesperidum* L. [*cf.* **39** 392].

RICHARDSON (C. H.). **Effects of insecticidal Fumigants on the Germination of Seed Corn.**—*J. econ. Ent.* **44** no. 4 pp. 604–608, 2 refs. Menasha, Wis., 1951.

In experiments on the effect of 14 fumigants, consisting of single liquid compounds or liquid mixtures, on the germination of maize, 5 lb. samples of seed from hybrid plants grown in Iowa in 1947 and 1948 were put in jars, the fumigants were poured on the surface of the grain, and the jars were closed, sealed with wax and kept at a constant temperature of 86°F. for seven days. Within one month of treatment and again after storage for 1·5–2 years, seed was tested for percentage germination by a modification of the official warm test, in which it was germinated at a constant temperature of 80°F., by a cold test, in which it was subjected to 48°F. and 90–95 per cent. relative humidity, and by the latter after treatment with a fungicide (Arasan SF containing 75 per cent. tetramethylthiuram disulphide) to determine whether the protection afforded against detrimental soil organisms would modify the results.

Acrylonitrile, chloropicrin, mixtures of these with carbon tetrachloride (1 : 1 and 3 : 17 by volume, respectively) and ethylene dibromide at insecticidal rates of application proved so highly detrimental to germination within one month that the older fumigated seed was not tested for viability. Carbon bisulphide proved less injurious, but the lowest safe dosage (1–2 U.S. gals. per 1,000 bushels) was close to the minimum for insect control. Carbon tetrachloride, alone and mixed with carbon bisulphide (4 : 1) or ethylene dichloride (1 : 3), ethylene dichloride alone, propylene dichloride and trichloroethylene appeared relatively safe and could be applied to seed maize at doses up to about 10 U.S. gals. per 1,000 bushels without much loss in germination. However, exposure time and the degree to which residual fumigant vapour is removed after treatment have important effects on viability. For the two mixtures and carbon tetrachloride alone at a dosage of 6 U.S. gals. per 1,000 bushels, an exposure for 3–5 days and aeration of the seed after fumigation are suggested. Limited tests indicated that the same dosage is safe for mixtures of ethylene dibromide with carbon tetrachloride (5 : 95) or with carbon tetrachloride and propylene dichloride (5 : 35 : 60). The age of seed maize before fumigation is probably less important in affecting viability than the time between fumigation and sowing.

The cold test proved more selective than the warm test, and treatment with the fungicide had little effect on the results.

FALES (J. H.) & STOUT (O. O.). **Aerosol Tests against the Oriental Fruit Fly and other Insects.**—*J. econ. Ent.* **44** no. 4 pp. 608–610, 2 graphs, 6 refs. Menasha, Wis., 1951.

In view of the danger of the spread of *Dacus ferrugineus* var. *dorsalis* Hend. from Hawaii to the United States in aircraft [*cf. R.A.E.*, A **38** 316–317], aerosols propelled by Freon-12 [dichlorodifluoromethane] were tested in 1948 against that fruit-fly and a few other insects that occur in the Islands with a view to developing a treatment for use in disinfesting aeroplanes leaving for the United States. Five formulations, designated by code numbers, were used in the main tests. They all contained 5 per cent. of a 20 per cent. pyrethrum extract and 3 per cent. DDT, but varied in other constituents, which are given with their percentages in brackets. They included G-382, which contained cyclohexanone (5), lubricating oil (2) and Freon-12 (85) ; this formula was approved for use in aircraft in September 1948 and proved highly effective against *Musca domestica* L. and mosquitos of two species at a rate of 5 gm. per 1,000 cu. ft. In a test of its effect on *Dacus*, it was released in a

testing room at 0·95 gm. per 1,000 cu. ft. and gave 62 and 63 per cent. knockdown of males and females, respectively, 62 and 64 per cent. kill after one day and 64 and 68 per cent. kill after two. The other four formulations all proved more effective than G-382 against *Dacus* when tested in the room and a Peet-Grady chamber. They comprised G-421, which contained piperonyl butoxide (8), cyclohexanone (7) and Freon-12 (77), G-500, which contained γ benzene hexachloride (3), piperonyl butoxide (8), cyclohexanone (10) and Freon-12 71), G-559, which contained piperonyl butoxide (4), cyclohexanone (5) and Freon-12 (83), and G-567, which contained piperonyl butoxide (2), cyclohexanone (5), lubricating oil (1), methyl salicylate (0·25) and Freon-12 (83·75). They have since proved unsuitable for use in aircraft, however, because of odour, irritation and an excessively high non-volatile content that would leave objectionable residues ; all but G-559 gave larger particles than was desirable.

Further tests with G-382 at rates up to 19·05 gm. per 1,000 cu. ft. showed that *D. f. dorsalis* was considerably more resistant than *M. domestica*, and tests with this aerosol, G-421 and G-500 against *Alphitobius laevigatus* (F.) (*piceus* (Ol.)), *Ammophorus insularis* Boh. and *Pycnoscelus surinamensis* (L.) at a rate of 20 gm. per 1,000 cu. ft. showed that it was the least effective and that more toxic formulations are needed to control the more resistant insects.

When adults of *D. f. dorsalis* were exposed to glass plates that had been treated with an aerosol that was designed to leave a toxic residue and was released from a solution of DDT (5 per cent.), cyclohexanone (5 per cent.), chlordan (5 per cent.), acetone (32·5 per cent.) and Freon-12 (52·5 per cent.), the lightest deposit (150 mg. per sq. ft.) gave complete kill after two days, indicating that under certain conditions such treatment might be effective against the fruit-fly.

FALES (J. H.), NELSON (R. H.), FULTON (R. A.) & BODENSTEIN (O. F.). **Tests with two insecticidal Aerosols for Use on Aircraft.**—*J. econ. Ent.* **44** no. 4 pp. 621–622, 4 refs. Menasha, Wis., 1951.

As some users objected to the cyclohexanone solvent in the liquefied-gas aerosol formula (G-382) approved in 1948 by the U.S. Public Health Service for the control of insects in aircraft [*cf.* preceding abstract], a new formula (G-651) was developed. It consisted of 6 per cent. pyrethrum extract (20 per cent. pyrethrins), 2 per cent. DDT, 8 per cent. methylated naphthalenes and 84 per cent. Freon-12 (dichlorodifluoromethane). Tests, the results of which are given, showed the two aerosols to be equally effective against *Musca domestica* L. and mosquitos of two species. G-651 was therefore recommended as a possible substitute for G-382 and was approved by the Service in March 1949. Both have since been used in aircraft. Formula G-651 is also used for the control of agricultural insects on aircraft headed for the U.S. mainland from San Juan, Porto Rico, and Honolulu, Hawaii. The dosage per 1,000 cu. ft. for occupied aircraft is 5 gm. in Porto Rico, whereas it is 7·5 gm. in Hawaii [because of the presence of *Dacus ferrugineus* var. *dorsalis* Hend.], and the same formula is used on unoccupied aeroplanes in Hawaii at 30 gm. per 1,000 cu. ft. It is important that the pyrethrum extract should contain not more than 1·5 per cent. material insoluble in Freon-12 to prevent clogging of the nozzle.

GURNEY (A. B.). **The Names of the Field and House Crickets.**—*J. econ. Ent.* **44** no. 4 p. 611, 14 refs. Menasha, Wis., 1951.

It is shown from a brief review of the literature that *Acheta* F. (1775), with type *Gryllus domesticus* (L.), is a valid generic name, and that *Gryllulus* Uv. [*R.A.E.*, A **23** 561] is consequently a synonym of it.

Only two Nearctic species of the genus, the house cricket, *A. domesticus*, and the field cricket, *A. assimilis* F., are now recognised, but it is possible that the latter represents several subspecies or species. B. B. Fulton has distinguished four races of *A. assimilis* in North Carolina that are differentiated by physiological characters, such as song, choice of habitat or seasonal history, but not by morphological characters. Mating of the different races under artificial conditions resulted in eggs that did not hatch.

BROWN (L. R.) & EADS (C. O.). **Experimental Control of Sycamore Scale with Combinations of Oil and certain synthetic organic Insecticides.**—*J. econ. Ent.* **44** no. 4 pp. 611–613, 4 refs. Menasha, Wis., 1951.

The author gives a short account of the life-history of *Stomacoccus platani* Ferris, which causes defoliation of sycamore (*Platanus* spp.) in southern California [*cf. R.A.E.*, A **31** 135 ; **33** 352], and an account of tests carried out with synthetic organic insecticides in the form of wettable powders alone or in oil emulsified with blood albumen in an attempt to find a more effective method of control than the application of dormant oil alone. Trees of *P. racemosa* were sprayed with the insecticides combined with fungicides in early February 1950 and samples of leaves taken at random from the lower periphery of each tree were examined in May for the number of scale injuries per 100 leaves or for percentage of injured leaves. The latter method proved more rapid and sensitive to differences between treatments. All spray quantities are per 100 U.S. gals.

A spray containing 2 lb. 25 per cent. parathion was the best tested and was equally effective whether applied alone or with 1·5 U.S. gals. light-medium oil. Sprays containing 4 lb. 25 per cent. benzene hexachloride, 2 lb. 50 per cent. DDT or 2·5 lb. 40 per cent. toxaphene with oil were the next best, but were little better than 1·5 U.S. gals. oil alone and useless without oil. Chlordan with or without oil was inferior to oil alone. The spray containing 1·5 U.S. gals. oil alone emulsified with blood albumen was more effective than one of 3 U.S. gals. oil emulsified with Bordeaux mixture, possibly because the latter made too stable an emulsion or because the lime combined with part of the oil and so reduced its effectiveness.

LLOYD (G. W.). **Insecticide Tests against the Potato Tuberworm.**—*J. econ. Ent.* **44** no. 4 pp. 613–614, 3 refs. Menasha, Wis., 1951.

In an experiment in Maryland on the protection of potato tubers from infestation by *Gnorimoschema operculella* (Zell.), the effectiveness was tested of dusting them, storing them in boxes sprayed on the inside (to simulate the spraying of storerooms and houses), and storing them in impregnated bags. Adults, which had been given an opportunity to pair, or pupae were introduced into the containers at intervals.

Dusts of pyrophyllite or 1 or 3 per cent. DDT, chlordan, toxaphene, γ BHC (benzene hexachloride) and methoxy-DDT (methoxychlor) all prevented injury completely after the first introduction of adults, but tubers dusted with 1 per cent. toxaphene and 3 per cent. DDT or methoxy-DDT became lightly infested after the second, a month later. In another test with pyrophyllite and the insecticides at 1 per cent., toxaphene and γ BHC prevented infestation after two introductions of cocoons at an interval of a month, whereas the other dusts prevented it after the second, but not after the first. When the tubers were exposed to oviposition for 24 hours before dusting, pyrophyllite and 1 per cent. DDT, chlordan, toxaphene, γ BHC and methoxy-DDT all prevented infestation. Untreated tubers became infested in all tests.

Spraying corrugated cardboard boxes with 3 per cent. chlordan or γ BHC in xylene prevented infestation in stored tubers after the introduction of adults three times at monthly intervals, and 3 per cent. DDT or toxaphene prevented it after the third introduction but not after the others. There was no infestation in treated boxes after one introduction of cocoons, and only slight infestation in those treated with toxaphene after the second, a month later. There was little infestation in untreated boxes.

When tubers in small burlap bags treated with 0·5 or 1 per cent. solutions of DDT, chlordan, toxaphene and γ BHC in xylene were exposed to adults in jars, only one tuber (in a bag treated with 0·5 per cent. toxaphene) became infested after the first introduction and none after the second, about six weeks later ; tubers in all untreated bags became infested.

ANTHON (E. W.) & WOLFE (H. R.). *Erythroneura dolosa* **and** *E. plena* **on Sweet Cherry in Washington.**—*J. econ. Ent.* **44** no. 4 pp. 614–615, 2 refs. Menasha, Wis., 1951.

Erythroneura dolosa Beamer & Griffith and *E. plena* Beamer have increased in numbers in eastern Washington of recent years. In 1947, they were abundant on cherry in several orchards in the centre, south-east and north-east of the State and by the summer of 1950, control measures were necessary in a few orchards in north-central Washington. The Jassids fed almost entirely on the lower surface of the leaves and caused a white stippling that increased until the whole leaf became pale green or white when infestation was severe. They were most injurious on the shaded inside and lower parts of the trees. The eggs were deposited in the tissue of the lower leaf surface and the nymphs were inactive but the adults very mobile. Some of the injury may have been due to *Typhlocyba rosae* (L.), which also occurred on some of the trees.

Populations in some orchards increased greatly by autumn, and in December 1948, after the leafhoppers in one had dropped to the ground with the leaves, an average of 139 per sq. ft. was found near the trunks of ten trees. They occurred mainly in the middle layer of leaves, where moisture and fungous infection were at a minimum, but the degree of winter survival is not known. In Washington, cherry appears to be the principal food-plant, although the leafhoppers have been collected from peach, chokecherry [*Prunus virginiana* var. *demissa*] and many other plants ; injury to peach [*cf. R.A.E.*, A **19** 493] was not reported, and *E. dolosa* did not reproduce on peach seedlings in the greenhouse. *E. dolosa* appears to be dominant in central Washington, while *E. plena* is more abundant in the north-east of the State.

One application of 2 lb. 50 per cent. wettable DDT powder per 100 U.S. gals. on 8th September reduced the number of *E. dolosa* per tree by more than 90 per cent. in one day and kept it low until the last count was made on 26th September, and one of 0·5 lb. 25 per cent. wettable parathion powder per 100 U.S. gals. on the same date, though slower in action, gave better control by 11th September and had an equally persistent effect.

MARSHALL (D. S.), MUKA (A. A.) & GYRISCO (G. G.). **Control of the Red-legged Grasshopper on Alfalfa with a low Volume-low Pressure Sprayer.**—*J. econ. Ent.* **44** no. 4 pp. 615–616, 2 refs. Menasha, Wis., 1951.

A heavy infestation of *Melanoplus femur-rubrum* (Deg.) developed in northern New York in 1950, and several organic insecticides were tested against it in a field of lucerne in low-volume sprays applied by a trailer-type weed sprayer with an 18 ft. boom suspended so that the spray from 15 fan-type nozzles coalesced just above the plants. This delivered 1 U.S. gal. spray per minute at a pressure of 40 lb. per sq. inch (about 20 U.S. gals. per

acre at a speed of 1 mile per hour). TEPP (tetraethyl pyrophosphate), chlordan, aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], toxaphene, BHC (benzene hexachloride), dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] and heptachlor [1(or 3a),4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-endomethanoindene] were applied during the evening of 25th July 1950 in concentrated emulsion sprays at 0·2, 0·4, 0·6 and 0·8 lb. actual toxicant (γ isomer in the case of BHC) per acre, and all killed more than 98 per cent. of the grasshoppers in two days with no injury to plants at all the concentrations used, and all but TEPP were still giving control a month later. BHC, dieldrin and aldrin, closely followed by toxaphene, were the most outstanding in persistent effect. The loss of toxicity of TEPP was correlated with a rapid loss in insecticidal residue, which suggests its possible use where grasshoppers are a problem on forage crops, especially near harvest.

The weed sprayer proved very satisfactory for use in the typical hilly country of New York. Sprays can be applied when conditions are unfavourable for dusting and are less liable to drift.

WOLFE (H. R.), ANTHON (E. W.), KALOOSTIAN (G. H.) & JONES (L. S.). **Leafhopper Transmission of Western X-Disease.**—*J. econ. Ent.* **44** no. 4 pp. 616–619, 10 refs. Menasha, Wis., 1951.

Western X-disease is a virus disease of peach that has been reported in Washington, Idaho, Utah, Oregon and Colorado. It is the counterpart of the disorder of peach termed X-disease in Connecticut, and a related or identical disease designated leaf-casting yellows of peach has been reported in California. The virus or viruses that cause Western X-disease are thought also to cause the disease of sweet and sour cherries termed Western-X-little-cherry. The native chokecherry (*Prunus virginiana*), of which the western form is var. *demissa*, is considered to be a host, but whereas the disease of peach in the east can be controlled by eliminating chokecherry for a distance of 500 ft., it appears that Western X-disease spreads in peach in the absence of chokecherry and Western-X-little-cherry in cherry orchards in the absence of this or any other stone-fruit host. Jassids were suspected of being the vectors of Western X-disease, and details are given of experiments in 1948–50 in which peach was infected by batches of nymphs and adults of *Colladonus geminatus* (Van D.), or adults only, after they had fed in succession on diseased peach and diseased sweet cherry, and by lots of 1–25 adults that had fed on diseased peach only. Tests in which infective Jassids were transferred to successive healthy peach trees showed that the virus normally underwent a latent period of at least 30 days in the vectors, although transmission was obtained after only 22 days in one instance, and that some individuals remained infective for at least 58 days. Infection was transmitted by single insects and to three successive peach trees when the Jassids were transferred at weekly intervals.

The preferred food-plants of *C. geminatus* are leguminous plants and grasses, but it survived and reproduced in cages on peach, apricot and cherry and has been observed feeding on peach and cherry in the field. It has been collected from chokecherry, pin cherry [*P. pennsylvanica*], willow and other plants that may serve as virus reservoirs.

WATTS (J. G.) & NETTLES (W. C.). **Control of the Sand Wireworm with chlorinated Insecticides.**—*J. econ. Ent.* **44** no. 4 pp. 619–620. Menasha, Wis., 1951.

Experiments were begun in 1948 on the value of chlorinated hydrocarbons against larvae of *Horistonotus uhleri* Horn (sand wireworm), which has made

the growing of crops difficult in much of the coastal plain of South Carolina. Chlordan, DDT and toxaphene at 0·5–4 lb. per acre and BHC (benzene hexachloride) at 0·125–1 lb. γ isomer per acre were mixed with fertiliser and applied to the soil immediately before maize was sown in a field that was normally heavily infested, but showed only moderate infestation during that season. All treatments increased the yield, but in no case did the yield vary directly with an increase or decrease of a particular toxicant, probably because of a lack of uniformity in infestation. Chlordan was more consistent in increasing yield than any other insecticide, and there were considerable differences in plant growth between untreated plots and those treated with it.

In demonstration plots, chlordan at 0·5–2 lb. per acre, BHC at 0·15–0·5 lb. γ isomer per acre and DDT at 0·5–0·88 lb. per acre applied with fertiliser prevented wireworm damage, which was severe in untreated plots, and caused great increases in yield, and in 1949, about 50 per cent., and in 1950, about 90 per cent. of all ground known to be infested was treated with 1 lb. chlordan per acre in fertiliser before being sown with maize.

Ginsburg (J. M.) & Filmer (R. S.). **DDT recovered on Corn Plants from different Treatments against Corn Earworm.**—*J. econ. Ent.* **44** no. 4 p. 620, 1 ref. Menasha, Wis., 1951.

The use of DDT to control the corn earworm [*Heliothis armigera* (Hb.)] on maize has become a standard practice in New Jersey, and since the maize stalks and husks are generally fed to livestock, analyses were made to determine the amounts of insecticide remaining at harvest on plants treated in different ways. DDT was applied in a 5 per cent. dust used at 40 lb. per acre on 8th, 16th and 21st August, at a concentration of 0·75 per cent. with oil in an emulsion spray (2 lb. actual compound per acre) on 11th August or at 1 per cent. in white mineral oil injected into the husk tips at the rate of 0·75 ml. per ear on 26th August, and whole plants were collected on 19th October and the leaves and stalks, husks, kernels and ear tips analysed for DDT residue. There was no DDT in shelled kernels after any treatment or in ear tips from dusted or sprayed plants, but ear tips treated by injection showed 52·85 parts per million. Husks contained about 21–26 p.p.m. DDT after the three treatments, and leaves and stalks from sprayed and dusted plots contained about 51 and 6·5 p.p.m., respectively.

Bartlett (B. R.). **A new Method for rearing *Drosophila* and a Technique for testing Insecticides with this Insect.**—*J. econ. Ent.* **44** no. 4 p. 621, 4 refs. Menasha, Wis., 1951.

The author describes a method of rearing *Drosophila melanogaster* Mg. in numbers on canned custard pumpkin and a modification of a technique for using the adults to test contact insecticides [*R.A.E.*, A **36** 164]. The flies for test are caged on filter papers that have been impregnated with acetone solutions of the insecticides and dried, and the periods for 50 per cent. kill are determined by periodic counts of accumulated mortalities.

Riherd (P. T.). **Status of the Rhodes Grass Scale Parasite in Texas.**—*J. econ. Ent.* **44** no. 4 pp. 622–623, 1 ref. Menasha, Wis., 1951.

A shipment of *Antonina graminis* (Mask.) parasitised by the Encyrtid, *Anagyrus antoninae* Timb., was received in Texas from Hawaii in the spring of 1949. The parasite was propagated and released in the field against *Antonina graminis* on various grasses, including *Sorghum halepense*, *Panicum*

purpurascens, *Stenotaphrum secundatum* and *Cynodon dactylon* [*cf. R.A.E.*, A **38** 493]. Establishment was hindered by dry cold weather, which was unfavourable to the grasses, but occurred in situations in which these remained in growing condition. In one instance, parasitised scale material was placed in August 1949 on infested *S. secundatum* on the banks of a canal near a *Citrus* grove containing infested *Sorghum halepense*, and the parasite emerged from scales collected in the area in January 1951. The parasite survived the very low temperatures of January and February 1951, and is known to occur in Japan, where temperatures are lower than in Texas.

LIENK (S. E.) & CHAPMAN (P. J.). **Influence of the Presence or Absence of the European Red Mite on Two-spotted Spider Mite Abundance.**—*J. econ. Ent.* **44** no. 4 p. 623, 1 graph, 2 refs. Menasha, Wis., 1951.

In 1950, investigations were carried out in western New York to determine whether the lateness of the seasonal activity of *Tetranychus bimaculatus* Harvey on apple [*cf. R.A.E.*, A **39** 12] was a result of competition from *Paratetranychus pilosus* (C. & F.) which occurs with it. Population records of *T. bimaculatus* were taken throughout the season in untreated plots and plots in which *P. pilosus* had been virtually eliminated for the season by treatments applied against the newly hatched first generation before flowering time. The results showed that although competition by *P. pilosus* may be an important factor, *T. bimaculatus* increased relatively slowly even in its absence and did not attain maximum activity until mid-August. These results suggest that early treatments against *P. pilosus* are of little value, since summer applications of acaricides will be needed in any case.

GAINES (J. C.) & REINHARD (H. J.). **A Sweet Clover Root Borer in Texas.**—*J. econ. Ent.* **44** no. 4 pp. 623–624, 1 fig., 1 ref. Menasha, Wis., 1951.

Larvae found boring in the roots of Madrid sweet clover in northern Texas in 1950 were identified as *Walshia amorphella* Clem., which had hitherto been recorded only from wild leguminous plants [*cf. R.A.E.*, A **32** 178; **36** 9]. The larvae tunnelled into the roots from the crown and sometimes killed the plants. Surveys in the late autumn revealed heavy infestations in three counties and lighter ones in seven. The Tineid was also found in Evergreen sweet clover and common biennial *Melilotus alba*, but not in lucerne or *Lespedeza*.

MENKE (H. F.). **Toxicity of some Insecticides to** *Nomia melanderi* **and** *Apis mellifera*.—*J. econ. Ent.* **44** no. 4 pp. 624–625, 2 refs. Menasha, Wis., 1951.

A dust mixture of 5 per cent. DDT (against *Lygus*) and 5 per cent. chlordan (against grasshoppers) applied to lucerne grown for seed in Washington in 1950 caused some poisoning of *Nomia melanderi* Ckll., the principal insect pollinator of the crop, and dusts of parathion and TEPP (tetraethyl pyrophosphate) applied against mites caused mortality of honey bees. In view of this, tests, of which some of the results have already been noticed [*R.A.E.*, A **39** 278], were carried out on the effects of various dusts on these insects.

A mixture of 5 per cent. each of DDT and chlordan applied at 30 lb. per acre and 1 per cent. TEPP at the same rate were very toxic to *N. melanderi* in cages in commercially treated fields, and 1 and 2 per cent. parathion was moderately toxic to *N. melanderi* and 2 per cent. parathion very toxic to honey bees released in hand-dusted cages.

SEVERIN (H. H. P.). **Newly discovered Leafhopper Vectors of California Aster-yellows Virus.**—*Hilgardia* **17** no. 16 pp. 511–519, 1 col. pl., 9 refs. Berkeley, Calif., 1947.

DELONG (D. M.) & SEVERIN (H. H. P.). **Characters, Distribution, and Food Plants of newly discovered Vectors of California Aster-yellows Virus.**—*T. c.* pp. 525–538, 6 figs., 14 refs.

In further studies on the Jassids that transmit the virus of California aster yellows [*cf. R.A.E.*, A **18** 17 ; **23** 412 ; **29** 301 ; **37** 143, 145 ; **38** 438], an account is given in the first of these papers of investigations in California on the effectiveness of five additional species that have recently been shown to be vectors. Tests with the short-winged and long-winged races of *Macrosteles divisus* (Uhl.) were included for comparison. The following is largely based on the authors' summary of the results. When males and females that had been reared on infected celery or collected in the field and kept on infected celery for ten days or more were put singly on healthy plants, the percentages of celery plants that became infected were 69 and 9 for the short-winged and long-winged races of *M. divisus*, 1, 13 and 77 for *Cloanthanus irroratus* (Van D.), *C. dubius* (Van D.) and *Euscelis maculipennis* DeL. & Dav., respectively, and 20 and 12 for *Fieberiella florii* (Stål) and *Chlorotettix similis* DeL., and the percentages of aster plants infected were 69 and 62 for the races of *M. divisus* and 1, 0 and 0 for *Cloanthanus irroratus*, *C. dubius* and *E. maculipennis*. The percentages of celery plants infected increased when batches of 5–40 adults of *C. irroratus*, *C. dubius*, long-winged *M. divisus*, *F. florii* and *Chlorotettix similis* were used, and those of aster when 40 males of *Cloanthanus irroratus* were used ; *C. dubius* failed to transmit the virus to aster when tried in batches of 40. The transference of single males or females that had caused infection in celery to fresh celery plants each day resulted in further transmission after 15 days by a male of *C. irroratus*, after 1–29 days by males of *C. dubius* and after 2–59 days by males and 3–13 days by females of *E. maculipennis*. Attempts to transmit the virus that causes Pierce's disease of grape vine and lucerne dwarf to vine seedlings and lucerne with *C. irroratus* and to grape with *E. maculipennis* and the virus of curly-top to beet with these species and *C. dubius* were unsuccessful. Adults of *E. maculipennis* taken in a lucerne field containing plantain (*Plantago major*) infected with aster yellows or on infected dandelion (*Taraxacum vulgare*) in August 1945 failed to infect celery, but individuals of the short-winged race of *M. divisus* taken with them infected asters.

The second paper contains accounts of the morphology of the adults of the five new vectors, their geographical range and their distribution and food-plants in California, and notes on the identity of *Cloanthanus acutus* (Say), which has not been shown to be a vector of the virus and does not occur in California, but has been confused with other species.

SEVERIN (H. H. P.). **Longevity of noninfective and infective Leafhoppers on a Plant nonsusceptible to a Virus.**—*Hilgardia* **17** no. 16 pp. 539–543, 2 refs. Berkeley, Calif., 1947.

In previous experiments, adults of nine species of Jassid vectors of the virus of California aster yellows that had completed their nymphal stages on infected celery or aster died when transferred to healthy celery or aster [*R.A.E.*, A **37** 144–145]. This might be because the virus itself was beneficial to the vector or because the food-plant was modified by virus infection to become more favourable to the insect. To determine whether the virus was directly beneficial to the vector, the survival of non-infective and infective individuals of the short-winged and long-winged races of *Macrosteles divisus* (Uhl.) on a

food-plant that is not susceptible to the virus was studied. The non-infective insects were reared on a variety of barley that is not susceptible to the virus, and the infective ones on diseased China aster (*Callistephus chinensis*) and plantain (*Plantago major*), and in January, soon after the last moult, batches of 50 or 100 males or females were caged on the barley and transferred to fresh barley plants each month. Records made monthly showed no mortality during the first month and inconsistent and non-significant differences during the next four, and it is concluded that the virus itself is neither beneficial nor injurious to these insects.

KASTING (R.) & WOODWARD (J. C.). **Persistence and Toxicity of Parathion when added to the Soil.**—*Sci. Agric.* **31** no. 4 pp. 133–138, 2 pls., 3 graphs, 7 refs. Ottawa, 1951.

The experiments described were carried out in view of the possibility that the continued use of parathion in orchard sprays might lead to accumulations of the toxicant in the soil, with consequent unfavourable effects on cover crops or soil micro-organisms. Lettuce, oats and vetch [*Vicia*] were sown in pots containing clay-loam soil with a pH of 6·8 that had been treated with parathion at rates of 0, 2, 12 and 100 lb. per acre, and the following is based on the authors' summary of the results. In all cases, the parathion had almost disappeared from the soil 325 days after application, and it is therefore not likely to leave dangerous residues although the orchards are heavily sprayed over several years. Even the highest rate of application had no observable detrimental effects on the plants or serious results on the microbiological balance of the soil. There was some evidence that parathion supplied additional phosphorus to the crops, and its use might therefore improve yields. Although young plants in soil that received the heavier rates contained relatively large quantities of parathion, the amounts present at harvest were not toxicologically significant.

MCBEAN (D. S.) & PLATT (A. W.). **Differential Damage to Barley Varieties by Grasshoppers.**—*Sci. Agric.* **31** no. 4 pp. 162–175, 2 pls., 28 refs. Ottawa, 1951.

Grasshoppers cause important losses of cereal crops in western Canada, both as nymphs and adults, but whereas the former can be controlled effectively by applying sprays or baits to the margins of the fields at the time of infestation, this method is not satisfactory against migrating adults or small populations present in the crop throughout the season, which may cause serious damage. Since treating the whole field is costly and injurious to the crops and varietal differences had been noted, especially in barley, in the amount of damage caused, 12 experiments were carried out in 1944–47 in which different varieties of barley were grown in ten localities and exposed to natural attack by grasshoppers. The species present varied somewhat with locality, but *Melanoplus mexicanus mexicanus* (Sauss.) predominated in most places.

The following is substantially the authors' summary of the results. Significant varietal differences in the amount of damage sustained, assessed as the percentage of dropped heads, were established in nine of the tests ; of the remaining three, grasshoppers were not sufficiently numerous to cause damage in two, and the plants were all destroyed at the seedling stage in the third. A total of 32 varieties was common to eight tests, and significant varietal differences based on the average from these tests were established. In 8 of 9 tests, significant positive correlations were established between grasshopper damage and the period before head formation. The protein content of the straw was positively correlated with damage in 7 of the 9 tests, but when partial correlations were

calculated with a constant value for the period before heading, there was a significant correlation with damage in only four. Plants of 98 hybrid lines produced by crossing a moderately resistant with a susceptible variety were tested at four stations in 1947. Damage in most of them was intermediate between that in the two parents, but fell outside these limits in a few. The resistance of the hybrids tended to resemble that of the resistant parent in two of the tests and that of the susceptible one in the other two. Damage to the hybrids was positively associated with the duration of the period before head formation in three and negatively in one of the four tests. There was no association between damage and awn barbing or rows of grain per head. There was some association between damage and degree of nodding of the spike in two tests and none in the other two.

Varietal differences in the susceptibility of barley to grasshopper damage are considered to be of economic importance and as such should receive consideration in breeding trials. The difficulty of obtaining a differential environment and the use of associated characters as a means of discarding susceptible segregates are discussed. It is considered that the association between resistance and earliness is more likely to be due to genetic linkage than to the escape of early maturing varieties from attack.

Borgman (H. H.). **De "rode vrucht ziekte" bij bramen, veroorzakt door de galmijt** *Eriophyes essigi* **Hassan.** [The Redberry Disease of Blackberries caused by the Gall-mite *Aceria essigi*.]—*Tijdschr. PlZiekt.* **56** pt. 2 pp. 149–160, 6 figs., 7 refs. Wageningen, 1950. (With a Summary in English.)

Blackberries of the variety Himalaya cultivated in a district in central Holland have of recent years been subject to increasing infestation by *Aceria* (*Eriophyes*) *essigi* (Hassan), which causes the condition known as "redberry" and has resulted in 50–90 per cent. loss of marketable crops on many plots. The mite is briefly described, and accounts are given, largely from the literature, of its distribution and life-history and of the damage that it causes [*cf. R.A.E.*, A **21** 539, etc.]. Since a spray of 5 per cent. lime-sulphur applied in February as recommended in the United States [*cf.* **24** 363], followed by one of 2·5–3 per cent. in mid-May, did not give satisfactory results, investigations on the habits and control of the mite in Holland were made in 1949. These showed that the mites that leave the fruits in autumn and migrate to sheltered sites, such as crevices beneath the bud scales and between the petioles and stems, usually on young shoots, apparently penetrate more deeply into them than they do in the United States [*cf.* **20** 21], so that few are to be seen on the surface by early December. They did not emerge from their shelters until the last week of March and were rare on the leaves in April.

In two experiments on control, sprays were applied four times between early April and late June, at the maximum concentrations recommended by the manufacturers. In the first, hexaethyl tetraphosphate, parathion and azobenzene gave little or no control, but mineral oil and lime-sulphur reduced the percentages of fruits damaged to 11 and 6, respectively, as compared with 38 for no treatment. In the second, parathion, wettable sulphur and lime-sulphur resulted in 43, 7 and 9 per cent. damaged fruits, respectively, as compared with 36. Possible times at which sprays can be applied are discussed, and it is concluded that the best results would be obtained by spraying with 8 per cent. lime-sulphur in late October or early November, after cutting and burning the old canes, followed by an application of either 3 per cent. lime-sulphur in spring when the shoots are 2–6 ins. long or one of wettable sulphur just before the flowers open. If necessary, a spray of mineral oil should be applied to the unripe fruits during the latter half of July.

Fransen (J. J.). **Aanvullend onderzoek omtrent gevoeligheid van de lariks-spinselbladwesp** (*Cephaleia alpina*) **voor enkele bestrijdingsmiddelen.** [Supplementary Investigations on the Sensitivity of *C. alpina* to certain Insecticides.]—*Ned. Boschb.-Tijdschr.* **20** no. 1 pp. 23–26, 6 refs. Wageningen, 1948.

Preliminary tests in 1942 having shown that dusts of sodium fluosilicate and calcium cyanamide were effective for the control of larvae of *Cephaleia alpina* (Klug) on larch in Holland, these materials were tested for contact effect in the laboratory in 1945. The larvae were dusted in an apparatus devised by the author [*R.A.E.*, A **26** 253], transferred to larch branches and observed daily for mortality : concurrently, their excreta were dried and weighed. The results showed that dusts of 40–100 per cent. sodium fluosilicate caused little mortality, though there were some reductions in the amount of excreta produced per living larva, and it was concluded that as the contact effect appeared to be slight, the effect of the dust might be rapidly destroyed in the field by rain. Dusts of 12·5, 25, 50 and 100 per cent. calcium cyanamide caused 35, 73, 95 and 100 per cent. mortality, respectively, in four days, and the production of excreta was rapidly reduced. The diluent was dolomite, and it is concluded that 12·5 per cent. calcium cyanamide in that material would constitute an effective contact poison against *C. alpina*.

Incomplete tests in 1946 showed that a dust of 5 per cent. DDT had no effect on the larvae, while 0·125 per cent. γ benzene hexachloride was very effective.

van Dinther (J. B. M.). **Twee Coccinellidae als roofvijanden van** *Dreyfusia piceae* **Ratz.** [Two Coccinellids as Predators of *Chermes piceae*.]—*Tijdschr. Ent.* **94** pt. 1–2 pp. 169–188, 2 figs., 7 refs. Amsterdam, 1951. (With a Summary in English.)

During the summer of 1949–50, *Abies* trees in the arboretum at Wageningen were found to be infested by *Chermes* (*Dreyfusia*) *piceae* Ratz. The Aphid was attacked during the following spring by the Coccinellids, *Aphidecta obliterata* (L.) and *Anatis ocellata* (L.), the larvae and pupae of which are described in detail, and the bionomics of the three insects were therefore studied. *C. piceae* overwintered on the trunks, branches and buds, mostly in the egg or the first nymphal instar, but occasionally in the second. The nymphs resumed development and the eggs hatched early in March, and the first adult females appeared and oviposited during the latter half of April. They laid about 100 eggs each, and oviposition continued until early June. Hatching began late in April. Aphids that hatched on the branches attacked the new shoots, inhibiting their growth and even killing them in some cases. Only sistentes were produced [*cf. R.A.E.*, A **33** 194]. Development was slow and some of the Aphids did not reach the second instar until the following spring Others gave rise to adults from August onwards, and eggs of the next generation were observed from early September, the adults laying 20–30 each. Some hatched in October, but further development soon ceased for the winter.

The first adults of *Aphidecta* appeared in mid-April, and eggs were laid from late April until mid-May in groups of 3–8 on the needles. The larvae fed on eggs of *C. piceae*. In captivity, females laid 62–98 eggs each in 2–3 weeks, at the average rate of 4–5 per day. From laboratory tests, it was estimated that a larva consumed about 2,500 eggs during its development. A table is given showing the duration of development at temperatures varying from 20 to 28°C. [68–82·4°F.]. At 20°C., the egg, larval and pupal stages lasted about 6, 18 and 9 days, respectively. Adults emerged in mid-June, but left the trees, probably because there were the no eggs of *C. piceae* available and the young Aphids were well dispersed.

Adults of *Anatis* first appeared in late April, and eggs were laid on the needles in batches of 8–10. The larvae hatched in mid-May and attacked the eggs of *C. piceae*. One batch of eggs was taken into the laboratory on 19th May and gave rise to adults on 9th July. By the time that the larvae reached the last instar, eggs of *C. piceae* had become scarce, and those of *C.* (*Gilletteëlla*) *cooleyi* Gill. [*cf.* **24** 572] were substituted. Both in the field and in the laboratory, the larvae attacked larvae and pupae of *Aphidecta* or larvae of their own species when food grew scarce. Adults appeared from the beginning of July, but also left the trees, although one batch of eggs, which subsequently hatched, was found on them.

Zattler (F.). **Spritzversuche in den Jahren 1946 und 1947 zur Verhütung des Kupferbrandes im Hopfenbau.** [Experiments in 1946 and 1947 with Sprays against *Tetranychus telarius* on Hops.]—*Anz. Schädlingsk.* **21** pt. 8 pp. 113–121, 7 figs., 8 refs. Berlin, 1948.

The cultural methods in use for the control of *Tetranychus telarius* (L.) (*Epitetranychus althaeae* v. Hanst.) on hops in Germany, which are reviewed, are insufficient in hot dry years and must be supplemented by acaricides, especially when late outbreaks occur while the cones are forming. For this purpose, various proprietary materials were tested in sprays in the field in August 1946 and 1947. The results are given in tables and showed that preparations containing DDT or benzene hexachloride had little effect on the mites, those containing colloidal sulphur were fairly effective, while lime-sulphur and an oil emulsion were good, but scorched the cones. E605f [which contains parathion] was the best material used. It did not harm the plants and, when applied at suitable concentrations, killed all the mites within 48 hours. It had little or no effect on the eggs, but acted as a repellent to the mites that hatched up to seven days after treatment. The technique of spraying is discussed. High-pressure apparatus is recommended, with two jets, one directed upwards from the base of the plants and the other directed almost vertically towards the tops. Sprays should be applied when the cones appear and repeated as necessary.

Kangas (E.). *Xylechinus pilosus* **Ratzb. und** *Polygraphus poligraphus* **L. (Col., Scolytidae) an der Kiefer.** [*X. pilosus* and *P. poligraphus* on Pine.]—*Ann. ent. fenn.* **15** (1949) no. 4 pp. 168–174, 1 fig., 12 refs. Helsinki, 1950.

Patches of drying bark were observed in June 1948 on the lower part of the trunk of a pine tree in a mixed forest in eastern Finland in which spruce predominated. Examination showed that the tree had been attacked by numerous insects, including *Xylechinus pilosus* (Ratz.), which had so far been recorded only from spruce and larch, and *Polygraphus poligraphus* (L.), which also normally attacks spruce.

Waloff (N.). **Observations on Larvae of** *Ephestia elutella* **Hübner (Lep. Phycitidae) during Diapause.**—*Trans. R. ent. Soc. Lond.* **100** pt. 5 pp. 147–159, 1 fig., 20 refs. London, 1949.

The following is virtually the author's summary of laboratory observations on larvae of *Ephestia elutella* (Hb.) carried out in England in 1943–46. Most of the larvae undergo a prolonged period of diapause, which lasts 8–9 months. As well as this univoltine strain, there exists a bivoltine strain, which produces the second generation each year. A non-diapausing stock producing successive generations was also isolated, but the temperature and nutritional limits within which it persists are narrow [*R.A.E.*, A **36** 264–265]. The quiescent larvae

metabolise slowly, producing solutions of nitrogenous waste continuously. Elimination of this waste is accompanied by loss in weight, and it is suggested that the production of the pupation hormone is delayed until a certain weight loss has occurred (roughly 35 per cent. of the original weight). The period of quiescence can be divided into a period of true diapause, in which high temperature does not initiate pupation, one of quiescence, in which pupation is delayed by low outdoor temperatures and during which high temperature initiates pupation, and the prepupal stage, characterised by the release of the pupation hormone.

HAMILTON (A. G.). **Further Studies on the Relation of Humidity and Temperature to the Development of two Species of African Locusts**—*Locusta migratoria migratorioides* **(R. & F.) and** *Schistocerca gregaria* **(Forsk.).**—*Trans. R. ent. Soc. Lond.* **101** pt. 1 pp. 1–58, 34 figs., 43 refs. London, 1950.

The following is virtually the author's summary of the investigations described, which were carried out in continuation of earlier work and by the same technique [*R.A.E.*, A **24** 227]. Experiments were carried out on hoppers and adults of *Locusta migratoria migratorioides* (R. & F.) and *Schistocerca gregaria* (Forsk.) at constant and alternating relative humidities and temperatures, and on eggs at constant and alternating temperatures. Alternating relative humidities and temperatures were calculated to give weighted mean relative humidities and temperatures. The limits of relative humidities between which hoppers develop and adults become sexually mature vary with temperature. The possible range of temperature for the development of hoppers and eggs of *Locusta* is from 53°F. to 118°F., and for *Schistocerca* from 63°F. to 114°F. Although adults can survive within these ranges, they become sterile if kept at very high constant temperatures (110°F. for *Schistocerca* and a little higher for *Locusta*). The optimal constant relative humidity for the development of *Locusta* hoppers and for percentage of hoppers reaching the adult stage varies from 65 to 68 per cent., depending on temperature, and for *Schistocerca* hoppers from 60 to 70 per cent. The optimal weighted mean relative humidity for both species varies from 70 to 80 per cent. The optimal temperature for the development of hoppers is 108°F. for *Locusta* and 101°F. for *Schistocerca*. The highest percentage of hoppers reaching the adult stage occurs at 94°F. for *Locusta* and 90°F. for *Schistocerca*. The optimal constant relative humidity for sexual maturation and number of egg pods per female is 70 per cent. for *Locusta*, and between 65 and 70 per cent., varying with temperature, for *Schistocerca*. The optimal weighted mean relative humidity is approximately 75 per cent. for *Locusta* and 78 per cent. for *Schistocerca*. At a constant relative humidity of 40 per cent. and below, *Schistocerca* adults go into a diapause, whereas *Locusta* adults never show any sign of a diapause. The optimal constant temperature for sexual maturation is 103°F. for *Locusta* and 98°F. for *Schistocerca*, while the maximum number of egg pods per female occurs at 93°F. for *Locusta* and 94°F. for *Schistocerca*. The optimal weighted mean temperature for sexual maturation is 85·7°F. (the highest tested) and for maximum number of egg pods per female 74·3°F. (the lowest tested) for both species. Within the range of relative humidity where sexual maturation occurs the length of adult life is closely linked with the time required to reach sexual maturity ; the faster the rate of sexual maturation, the shorter the life. The maximum number of eggs per egg pod and hoppers hatching occurs at a constant temperature of 80°F. for *Locusta* and 90°F. for *Schistocerca*, but at weighted mean temperatures of 77·1°F. for *Locusta* and 74·3°F. for *Schistocerca*. A comparison between constant and alternating temperatures shows that both species deposit more eggs per egg pod when conditions are alternating than when

they are constant. In both species, quantitative activities (the number of hoppers reaching the adult stage and the number of egg pods per female) have approximately the same optimal temperatures. Speed activities (the rate of hopper development and sexual maturation of adults) have higher optimal temperatures, therefore no one temperature can be regarded as optimum for all functions of hopper and adult life.

GIVEN (B. B.). **Notes on the Aphodiinae of Australia (Coleoptera, Scarabaeidae). The** *Aphodius tasmaniae, howitti, yorkensis, andersoni* **Complex.**—*Proc. Linn. Soc. N.S.W.* **75** pt. 3–4 pp. 153–157, 20 figs. Sydney, 1950.

CARNE (P. B.). **The Morphology of the immature Stages of** *Aphodius howitti* **Hope (Coleoptera, Scarabaeidae, Aphodiinae).**—*T.c.* pp. 158–166, 1 pl., 13 figs., 7 refs.

The identity of species of *Aphodius* in Tasmania and the mainland of Australia is reviewed and discussed in the first paper. From an examination of the types of *A. howitti* Hope, *A. tasmaniae* Hope and *A. andersoni* Blkb., E. B. Britton in correspondence confirmed the view that they represent one species ; this is the species that is injurious to pasture on the mainland and it also occurs in Tasmania. The name *howitti* is adopted for it, though others who hold the same view have used the name *tasmaniae* [*R.A.E.*, A **21** 349 ; **22** 447 ; **26** 85 ; **29** 335]. He further stated that although most of the specimens labelled *tasmaniae* in the collections of the British Museum can be referred to *howitti*, five with hairy elytra evidently represent another species. This is apparently restricted to Tasmania and has been misidentified as *tasmaniae* [**29** 547]. Comparisons of 7 males and 15 females of this species from Tasmania and 18 males and 16 females of *A. howitti* from the mainland showed constant differences in the male genitalia, the presence of conspicuous rows of hairs on the elytra of the males from Tasmania but on no other specimens and differences in the head tubercles, and the author here describes the Tasmanian species as *A. pseudotasmaniae*, sp. n. Descriptions of the adults of *A. howitti* and of *A. yorkensis* Blkb., a species of no economic importance that is stated in the second paper to be confined to the Yorke Peninsula in South Australia, are included. *A. pseudotasmaniae* is not known to occur outside Tasmania, and *A. howitti* occurs from the Eyre Peninsula through south-eastern South Australia and Victoria to south-eastern New South Wales, as well as Tasmania.

The second paper contains a detailed description of the third-instar larva of *A. howitti*, together with characters distinguishing the three larval instars and briefer descriptions of the egg and pupa.

PAPERS NOTICED BY TITLE ONLY.

MILLER (N. C. E.). **A New Species of** *Afrius* [*williamsi*, sp.n.] **(Hem., Pentatomidae) predacious on** *Schematiza cordiae* **Barb.** [introduced for control of *Cordia macrostachya*], **in Mauritius.**—*Bull. ent. Res.* **42** pt. 1 pp. 183–184, 1 fig. London, 1951.

MELTZER (J.). **Eigenschappen en giftigheid van hexachloorcyclohexaan.** [The Properties and Toxicity of Benzene Hexachloride (a review of the literature).]—*Tijdschr. PlZiekt.* **56** pt. 2 pp. 101–148, 6 figs., 151 refs. Wageningen, 1950.

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